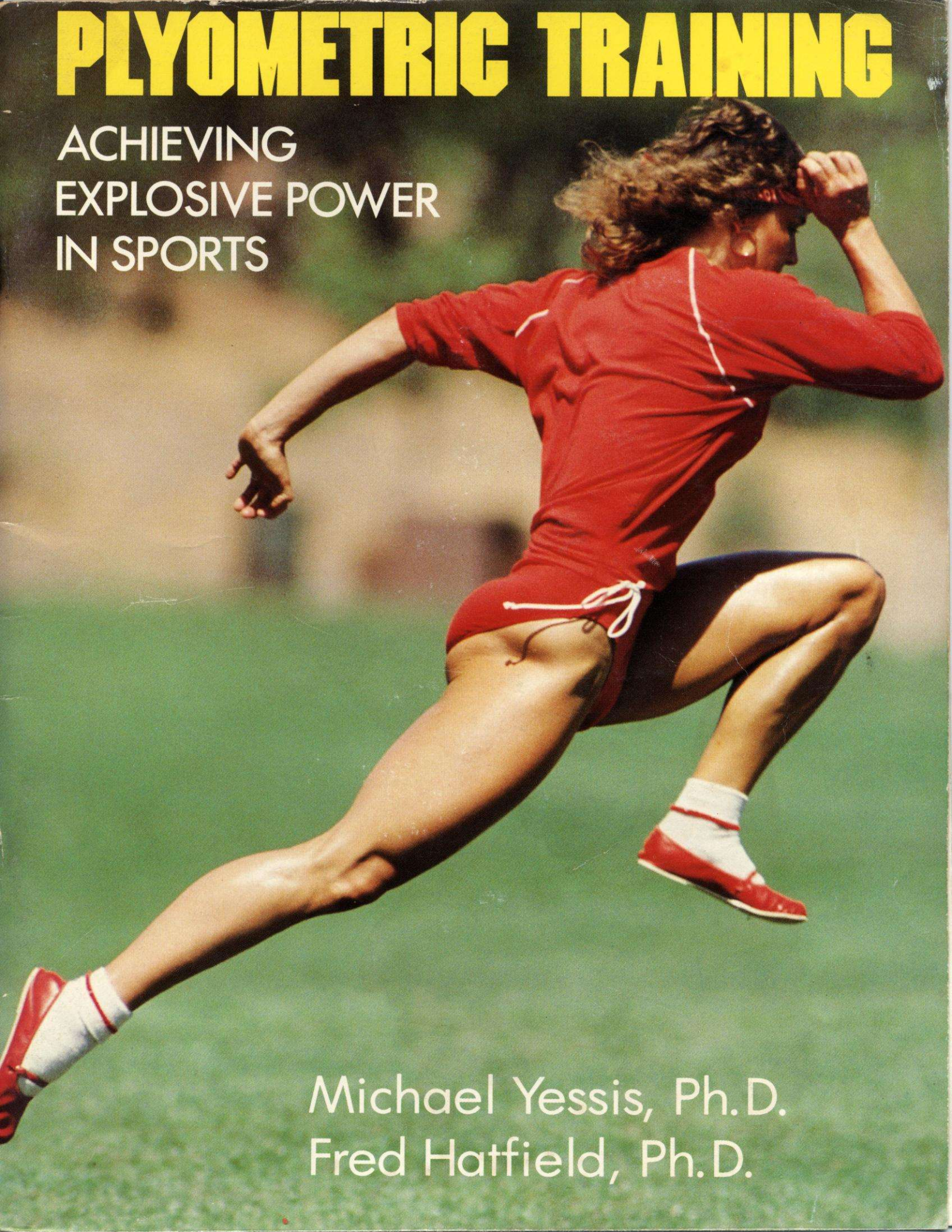
PLYOMETRIC TRAINING

ACHIEVING EXPLOSIVE POWER IN SPORTS



Michael Yessis, Ph.D.
Fred Hatfield, Ph.D.

PLYOMETRIC TRAINING

Achieving Power and Explosiveness in Sports

Michael Yessis, Ph.D.

Frederick C. Hatfield, Ph.D.

Copyright © 1986, 2007 Michael Yessis and Fred Hatfield. All rights reserved. No part of this information may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording, distributing, or by any information storage or retrieval system, without permission in writing from the author. Inquiries should be addressed to DrSquat.com Webmaster, 6006 Eldorado Drive, Tampa, FL 33615, USA. If you would like to offer any of the e-books on www.drsquat.com , whether on your site or elsewhere, please contact DrSquat.com Webmaster at the address above or via e-mail at admin@drsquat.com.

For complete information on all Dr. Squat's e-booklets, products, programs and more valuable information available to help you get stronger, faster, healthier, lose fat or train for your sport, visit www.drsquat.com.

For complete information on all Dr. Yessis' e-booklets, products, programs and more valuable information available to help you get stronger, faster, healthier, lose fat or train for your sport, visit http://www.dryessis.com.

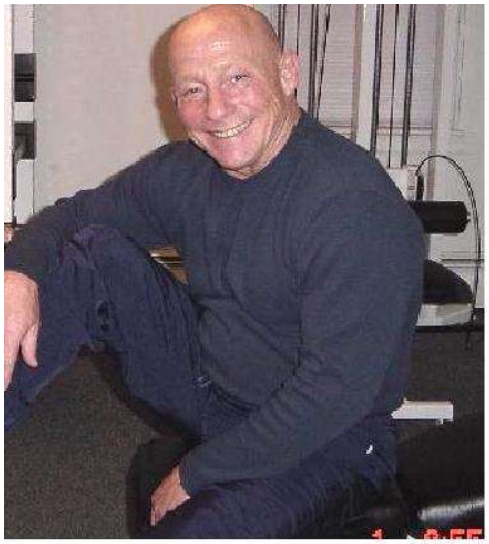
Michael Yessis, Ph.D.

Dr. Michael Yessis is President of *SPORTS TRAINING, INC.*, which specializes in the development and training of athletes, development and evaluation of exercise equipment, and sports fitness consulting. Dr. Yessis is also Director of Strength and Conditioning at the Professional Golfers' Career College in Murietta, California, and for professional tennis players with Maverick Sports.

In addition, he is Professor Emeritus at California State University, Fullerton, at present he serves as Editor-in-Chief of the *FITNESS AND SPORTS REVIEW INTERNATIONAL* and is associate editor of the *NATIONAL STRENGTH AND CONDITIONING ASSOCIATION JOURNAL.*

He has been training and technique consultant to several Olympic and professional sports teams, such as the L.A. Rams and L.A. Raiders football clubs, Natadore Diving Team, U.S. Men's Volleyball Team and many athletes from the Youth Congress to professional players. At the Golf College he develops strength exercises which duplicate specific portions of the swing.

Frederick C. Hatfield, Ph.D.



President and co-founder of the *International Sports Sciences Association* (ISSA), Dr. Hatfield (aka "Dr. Squat") won the world championships three times in the sport of powerlifting, and along the way broke over 30 world records, including a competitive squat with 1014 pounds at a bodyweight of 255 pounds (more weight than anyone in history had ever lifted in competition). Former positions include an assistant professorship at the University of Wisconsin (Madison) and Senior Vice President and Director of Research & Development for Weider Health & Fitness, Inc. Dr. He has written over 60 books and hundreds of articles in the general areas of sports training, fitness, bodybuilding and nutrition. In addition to serving three times as the national coach of the U.S. Powerlifting Team, he has been coach and training consultant to scores of world-ranked and professional athletes as well as sports governing bodies and professional sports teams worldwide. He hosts one of the most popular Q&A Boards on the internet at www.drsquat.com.

Acknowledgements

To my sources of inspiration, Edie and Marissa.

Mike Yessis

To the athletes I've trained, who've had to put up with my training
Methods and procedures while I was learning them myself,
I humbly extend my thanks and apologies.

Fred Hatfield

All illustrations taken from the original Russian literature.
Photos of Dr. Hatfield's son, Freddy, taken by Drs. Hatfield and Yessis.
Front Cover photo of Cory Everson by Mike Neveux (see Cory's Foreword).

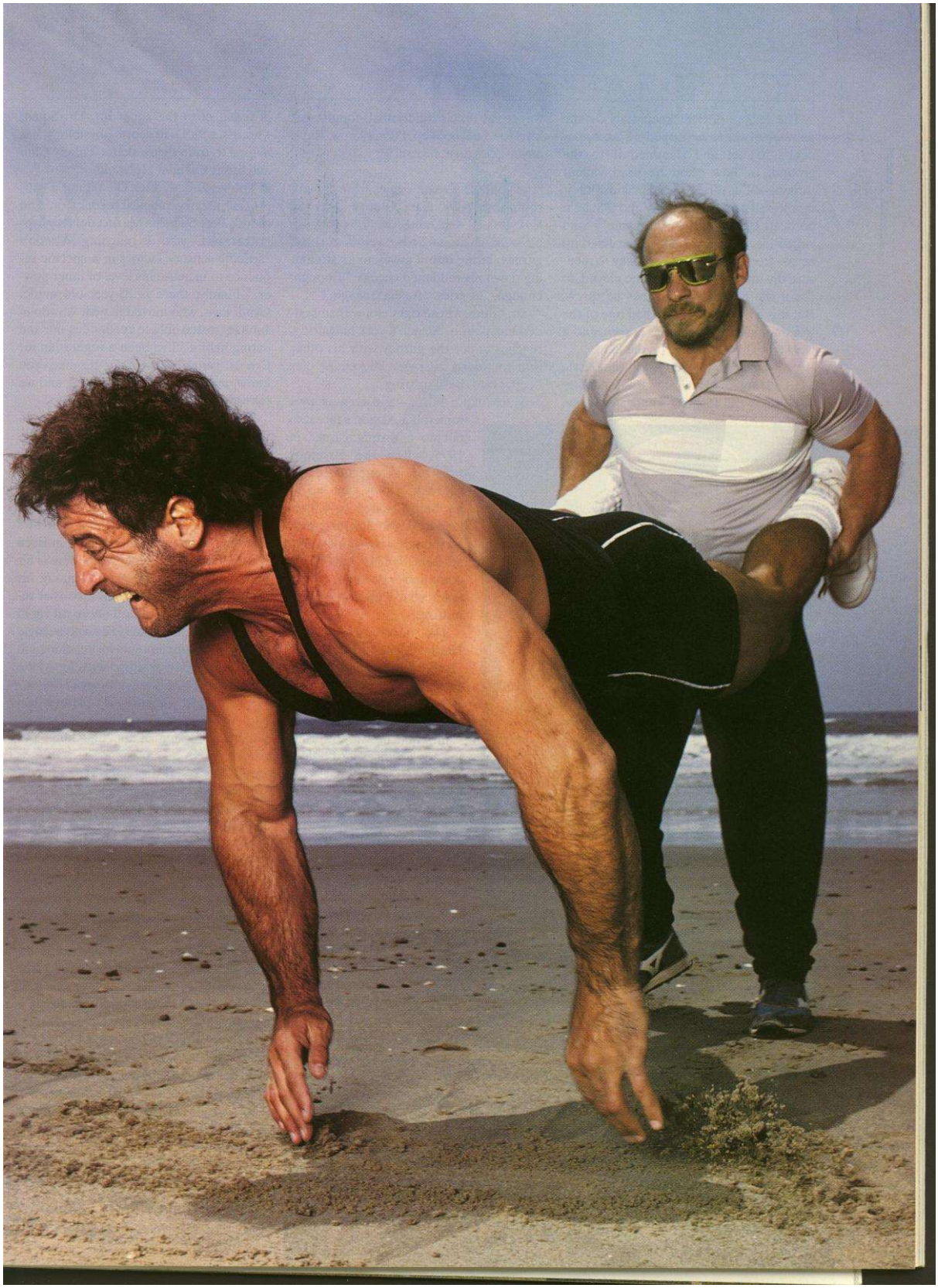
Table of Contents

Chapter 1. Why Plyometrics? 10
Chapter 2. The Many Faces of Strength 15
Chapter 3. Physiological and Biomechanical Factors Involved in Plyometrics ... 21
Chapter 4. Methods of Plyometric Training 31
Chapter 5« Explosive Legs for All Sports 43
Chapter 6. Explosive Arms for All Sports 58
Chapter 7. Total Body Explosiveness 68
Chapter 8. How to Fit Plyometrics Into Your Personal Program 78

Foreword

"In college, at the University of Wisconsin, I thought my track coaches were deranged. They used to hook me up with a rubber cable to a motor scooter. Then someone drove around the track and I had to sprint so fast to keep up with them that if I didn't, I'd fall flat on my face. I ran faster than I ever could have on my own. I ran sprints downhill, bounded like a kangaroo and ran backwards so much, I didn't know if I was coming or going! There was a method to this madness though. I won the Big 10 pentathlon three times. My legs grew like weeds. Today, I'm Ms. Olympia and people tell me I have the best legs in bodybuilding. If that's so, plyometrics is the reason why. They made my legs what they are today."

CORINNA EVERSON
Ms. Olympia 1984/85



Lyly Alzado with Dr. Fred Hatfield
(Photo appeared in Sports Illustrated, July 2, 1990).

Chapter One

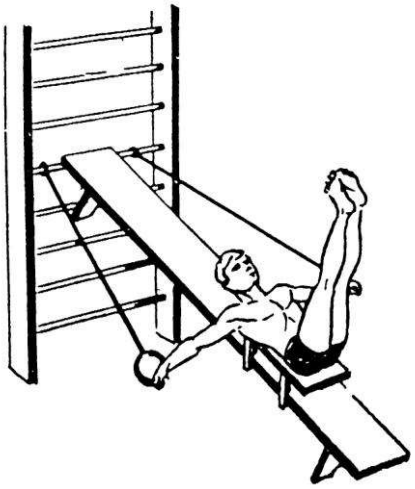
Why Plyometrics?

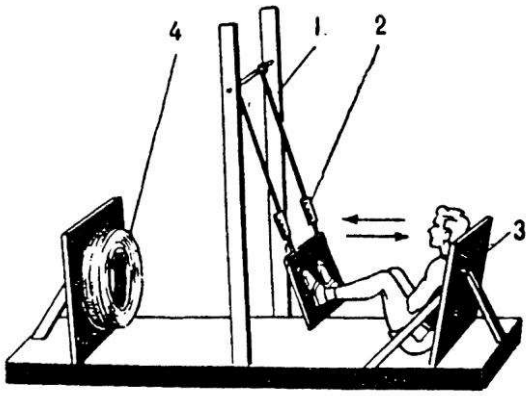
At present and for the past 10-20 years, strength training has been the principle method for conditioning and preparing athletes for participation in their sports. Thirty years ago lifting weights for strength development was looked down upon and most athletes were not allowed to lift weights. The prevalent thought at that time was that the lifting of weights would make you tight, muscle bound, and would not allow you to execute the movements as needed in your sport. Today, we know that this is not so.

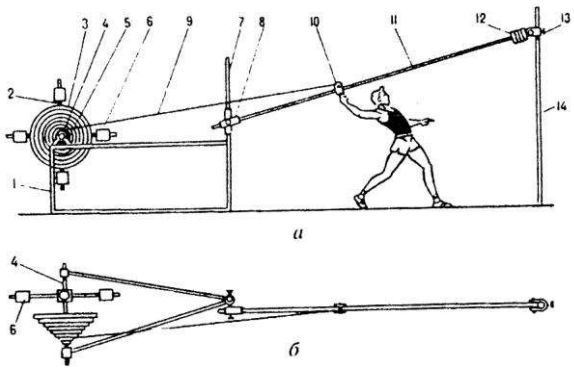
There is no questioning the fact that strength plays a major role in improving performance and preventing injury. From the knowledge that we presently have, it will always be important as a base, and in some cases the main, physical quality needed in sports. However, in close examination of almost all sports, it can be seen that strength is definitely important but speed and explosion are even more important!

For example, in the javelin throw, in which you use a light weight, it is necessary to bring the hand through with maximum speed. In the shot put, in which a moderate weight is used, you also need maximum speed of the hand prior to release. In basketball and volleyball, for example in vertical jumping, the jumps must be executed with maximum speed and explosiveness. In weightlifting, in which you overcome maximally heavy weights, speed is, once again, most important. Without maximally fast movements of the body, you would find it impossible to complete the two weightlifting events (snatch and clean and jerk). In fact, it can be said that speed and explosive training will be the new wave of the future.

To show that explosiveness is important, we can use an example from running and jumping. In running, the foot is in contact with the ground for 0.1 second and in jumping (Fosbury flop), the foot is in contact with the ground approximately 0.2 second. However, in a voluntary muscle contraction, it takes 0.6-0.8 second to develop a maximal muscular contraction.





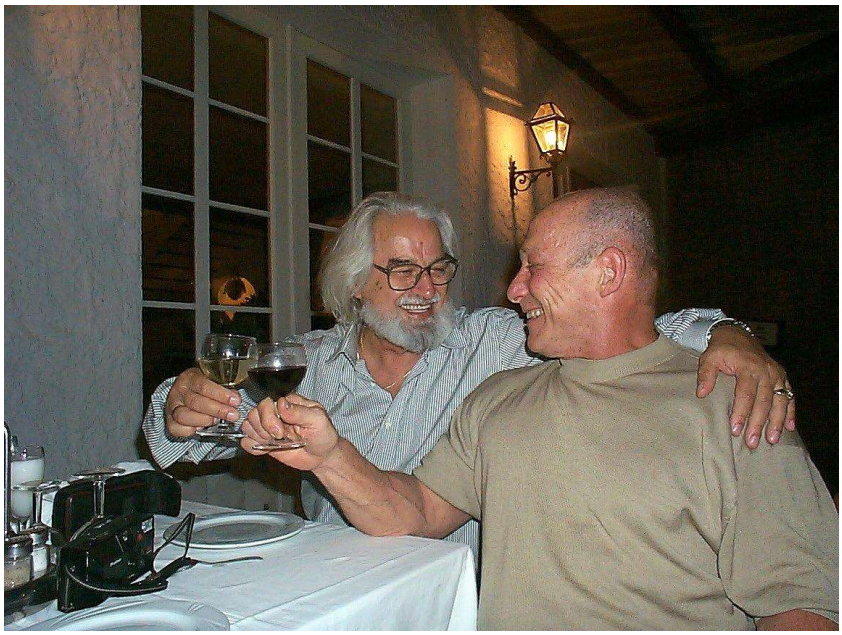


In other words, the sports movement is executed in much less time than it takes for the muscle to develop a maximal contraction. (You usually use only 60-80% of your absolute strength in most sports skills). Thus, the key element in training is to display strength as quickly and as forcefully as possible. To do this, you must use plyometrics. It is the key method known to develop explosiveness, which is also a key element in speed.

The term plyometrics was first used in 1975 by Fred Wilt, former Olympic runner and present women's track coach at Purdue University. According to Wilt, he got the term from European track and field coaches where plyometrics was in use at least ten years before this time. The Soviets were strong users of plyometrics and their early success in the jump events was credited in large part to this type of training.

Since that time, the use of plyometrics in the Soviet Union has been expanded to

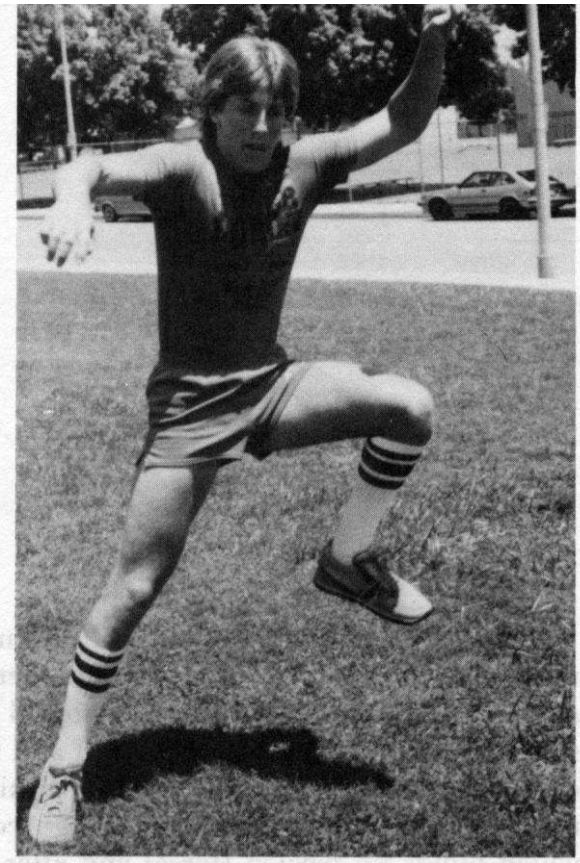
where it is now used in almost all sports for the development of speed and explosiveness.The leading coach and researcher who was most responsible for the spread of plyometrics and its various forms was Yuri Verkoshansky. He has done more research than anyone else in the world on this form of training and is recognized as its leading expert. In fact, many of the descriptions of plyometrics and the various methods of using it have been developed by Verkoshansky.

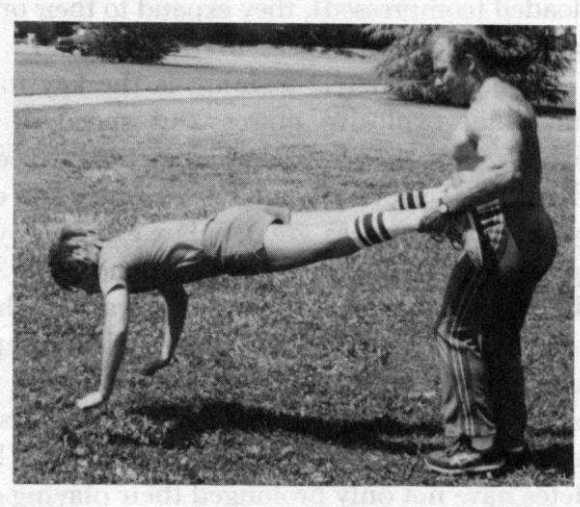


Verkoshansky and Hatfield enjoying their discussions on training
In the way such discussions were meant to be enjoyed!

The use of plyometrics has had a slow acceptance in the U.S. In part, this was due to lack of information and a certain reluctance by some coaches to accept anything foreign, even though its value had been well established. The first information was published in the Yessis Review of Soviet Physical Education and Sports (now the Soviet Sports Review) in the late 1960's and early 1970's. Soon after, Wilt and others had some articles published and in the early 1980's many more articles and several books appeared which dealt with plyometrics.

Today, because of the success achieved by coaches and athletes from using plyometrics, it is becoming universally accepted. And rightfully so! Plyometrics and other forms of explosive training have proven their value in the total training of athletes.





Plyometrics has many forms but, in general, it revolves around jump activities. For example, single or double leg hops, triple jumps, quintuple jumps, tenfold jumps, jumps for height, distance or a combination of both, jumps onto and off objects, jumps with turns, jump downs with a hold (altitude jumps), and jump downs with a following jump upward (depth jumps). Such jumps are used to develop either the arm or leg explosiveness or a combination of both.

Specialized devices are also used to develop explosiveness as a separate quality or in a specific manner to more closely duplicate the skill involved in the sport. For example, presently used are sleds on rails set on an angle in which you slide down into a resilient surface and push off with maximum speed. Also used are swings in which you swing into a resilient surface and push off with a quick action, catching and throwing weighted objects (medicine balls, shot put, sand bags), a weighted pendulum device, or the use of heavy bags as found in boxing. There are also guided pulley throws for arm action as in the javelin throw and other pulling actions to duplicate specific movements of a sport skill.

Exercises with weights are also used to help develop quick movement and explosiveness. In

fact, because of the speed and explosive nature of the weightlifting events, it can be said that weightlifters are the fastest athletes in the world, due mainly to their explosiveness. If you place a World class weightlifter next to a World class sprinter in the blocks, the weightlifter will usually beat the sprinter for the first 5-10 yards!

In exercises for explosiveness, the object is to develop the ability to generate the greatest force in the shortest amount of time. In the process, your muscles develop elasticity (resiliency), which is the key to explosiveness and is one of the. outcomes from doing plyometrics.

When doing the various forms of plyometrics, your muscles become loaded, or coiled, and then the energy accumulated from the loading is switched in direction so that your body becomes unloaded and in the process is propelled upward and forward. At this time, your muscles act as springs. They undergo compression, which builds up tension (force) and after being fully loaded (compressed), they expand to their original shape and in so doing release the force upward

Thus, plyometric training is the key to developing maximal explosive power and speed of movement, which, in turn, are the key elements involved in sports. By doing various plyometric exercises, you can increase your performances greatly. For example, you can improve your 10 yard dash by 0.1 second, your 20 yard dash by 0.1-0.2 second, and your 40 yard dash from .1-.4 second. You can increase your vertical jump from 1-5" after 3-6 months of training and improve your agility significantly. Such results are not dreams or wishful thinking—they have actually been achieved! These athletes have not only prolonged their playing careers, but have improved the quality of their play tremendously. You too can experience this successful improvement by incorporating plyometrics in your training after establishing a firm strength base.

Chapter Two

The Many Faces of Strength

Throughout the remainder of this book, you will be reminded again and again of the importance of strength in achieving athletic performance capabilities that are beyond the norm. Words and phrases like "explosiveness," "absolute strength" and "starting strength" will appear in every chapter.

That's because this book is all about plyometric training. Plyometric training is designed to increase two critical elements of strength, starting strength and explosive strength. Also, strength is inherently important in all aspects of life, not just sports in specific. Strength is essential to all forms of human movement, from lifting a fork to hoisting gargantuan weights. It's the physical quality that underlies and enhances all others, and it provides an important margin of injury prevention.

In the past decade, a number of major studies of this physical quality have taken place—mostly in the Soviet Union and Europe. The overall concept of strength has been broken down and its components identified, giving us an even greater understanding of what strength is and how it can best be developed.

The Many Types of Strength. In general terms, strength refers to the force that you can produce, and absolute^ or maximum, strength represents the most force that you can produce. The quality of absolute strength is further broken down into three separate components—concentric, eccentric and isometric.

For the sake of illustration, we'll use the biceps curl. Let's say your maximum curl is 100 pounds. You can't curl 101 pounds. That is your absolute strength level in a concentric biceps contracture. Most people can hold about 15 percent more in a still, or static, position than they can move concentrically. Thus, you'll be able to hold about 115 pounds in the mid position of a curl. That is your absolute isometric strength. And if you were to swing a weight up and lower it slowly, using your eccentric strength, you'd find that you could lower about 35 to 40 percent more than you were able to lift concentrically. In other words, your absolute eccentric strength is about 35 to 40 percent higher than your absolute concentric strength.

In concentric strength, your muscle contracts, which causes it to shorten. Eccentric strength is illustrated by the opposite movement in which you allow the biceps to lengthen by straightening your arm while lowering the weight. Isometric strength represents the amount of force you can exert in any given position of the joint wherein the weight of the load and the force of the contracture are equal.

In research as well as in practice, the most common type of strength demonstrated is concentric strength.

In addition to these three basic components, there are a number of other ways of classifying the quality of strength:

Strength endurance is the ability to put out maximum effort time with no appreciable diminishing of force. If you were a boxer, you'd want to be able to hit your opponent as hard in the 10th round as you could in the first. For this you need strength endurance. You can also see how important this type of strength would be to a basketball player, soccer player, crew member, wrestler or karate master.

Relative strength refers to the amount of strength (concentric, isometric or eccentric) that you can generate in relation to your body weight, expressed as strength per kilogram of weight. This figure is used to help compare the strength capabilities of different individuals.

Limit strength refers to the extra margin of voluntary force that you can generate above and beyond your absolute strength level through the use of such ergogenic aids as drugs, hypnosis or psychological factors.

Absolute strength is the cornerstone upon which you build peak performance for most sports. But it's only the foundation. It's not the end of the story, as it was for the old-timers who didn't really understand the nature of their sports' requirements or how to truly maximize their athletic potential. Nowadays, if you're training scientifically, you have to take your absolute strength levels a step higher.

Speed-strength is what Russian scientists call that next step: We call it power. We call it explosiveness. Actually, there are two types of speed-strength. Starting strength is the ability to instantaneously recruit as many muscle cells as possible. It's the primary

requisite for throwing a baseball, long jumping 28 feet, running the 100 meters in 10 flat and other explosive movements that are done with little more than body resistance.

Explosive strength, on the other hand, is the ability to keep that initial explosion of muscle contracture going over a distance against considerable resistance. Examples of explosive strength range from little or no resistance through mild resistance (shot putting, football blocking, 56-pound weight throw, etc.) to maximum resistance (Olympic weightlifting or powerlifting).

The lighter the implement you have to move and the shorter the distance, the more your starting strength becomes important; the heavier the resistance and the longer the distance, the more important your explosive strength becomes.

While explosive strength is built on the foundation of absolute strength, the training for each is worlds apart. You begin your cycle building absolute strength, and you end it—right before a contest—by training for explosive strength.

These different categories of strength are obviously all interrelated. For example, absolute strength is the basic quality that influences strength endurance and speed-strength.

Following are some guidelines which you can follow in planning and executing your exercises:

1. **The specialized exercises should correspond by form and muscle work involved in your sport. Also the range of motion you use in your exercises must be the same as in the sports event.**
2. **The strength exercises must correspond to the direction of movement. For example, in sprinting, your leg moves toward the rear and so the exercise movement should be directed toward the rear.**
3. **The action where your effort is at maximum in the range of motion should be accentuated. For example, in running when you bring your thigh through with hip joint flexion, maximum effort should be displayed at the start of bringing the thigh through. After your leg has passed underneath the body, force should be diminishing and not increasing. Thus, when doing speed- strength exercises you**

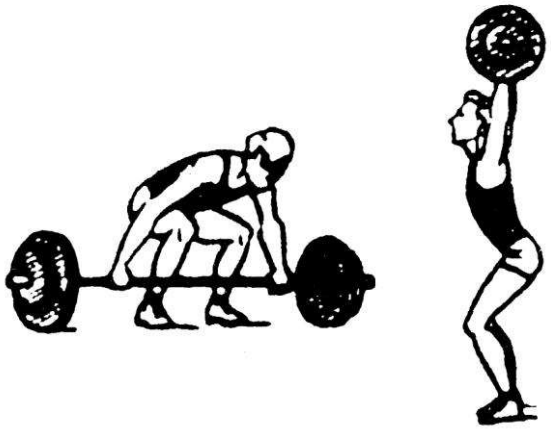
must explode at the beginning of the movement and let inertia carry the limb the rest of the way.

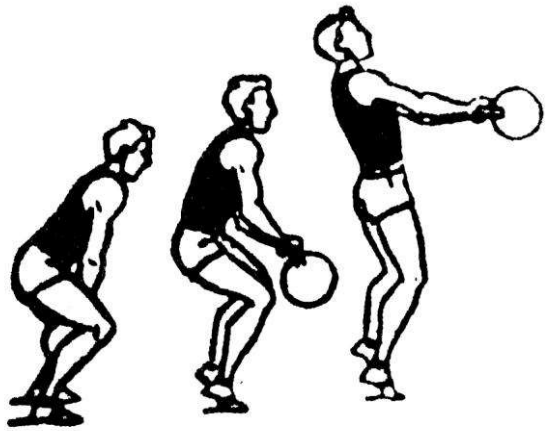
4. In order to get a maximum muscular explosion, you must be "psyched" prior to the explosive movement. Maximum effort must be displayed during the exercise. If it is lower than maximum, the effect will be lower. In addition, the effort must exceed the maximum in the competitive event. In this, the nervous system learns to experience the speed being generated and then it can duplicate this speed in the competitive event.
5. The speed of development of maximum force should correspond to the sports event. To do this, you can use a variable method in which you do one exercise with maximum weight to develop maximum force. This is then followed by an exercise with light weights in which you develop quick force. In the variation method you can use heavier and lighter weights in the same workout. After using heavier weights and you go to lighter weights you will experience the feeling of speed. You then relate this feeling to the sport. However, in this method the difference in weight is not great.
6. The muscle work regime must correspond to the competitive event. Most errors are usually made here as many athletes train too heavy too often or go to exhaustion in their workout. The key is to allow sufficient rest between sets or exercises so that there is restoration of the ATP stores before progressing on to the next set or exercise.

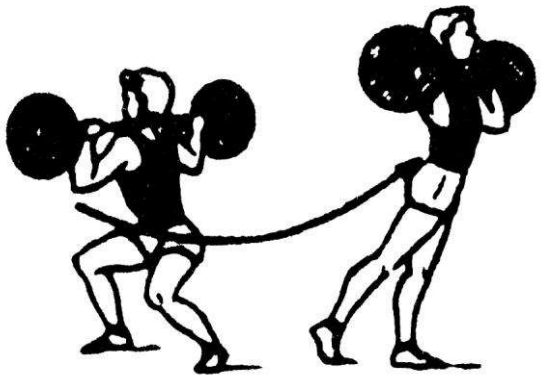
Absolute strength must also be increased if you want to increase your explosiveness. Here the type of workout used will depend upon the level of athlete that you are. For example, if you are just beginning, you should do a 10 maximum repetition (10 RM) routine to develop both mass and strength. This provides for an effective base upon which to do higher intensity training at a later time.

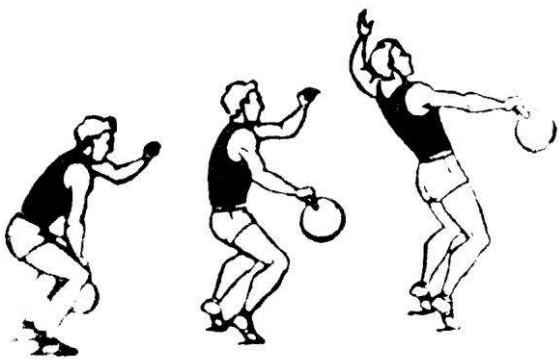
For average athletes, the one-half of 10 RM followed by three-quarters of 10 RM and 10 full RM are used. For the top level athlete, a 10 RM-5RM-3RM routine is most effective. A one RM routine is only used once every 2-3 weeks to determine new levels and to measure progress.

To develop maximum isometric strength you usually apply between 90-100% of maximum force and hold for between 5-6 seconds. Usually there are 4-5 sets of 2-3 repetitions.









To develop maximum eccentric strength you must use approximately 120-150% of maximum concentric strength. Usually there are 3-5 repetitions for three sets with a rest period of three minutes in between. However, it should be noted that in this exercise regime you need help from experienced training partners in over-coming the weight in the concentric regime.

Thus, you should have two assistants with you at all times when doing such training. Also, it should be noted that because of the tremendous tension that is built up, your muscles should be strong before undertaking this kind of muscle contraction training. Do not do maximum eccentric training if you are only a beginner or intermediate unless the resistance is much less (80-100% of concentric strength). If you do, it may be injurious to your ligaments, tendons, and other support structures.

In general, the concentric regime should comprise approximately 75% of the total number of lifts that you do for the year. Isometric and eccentric should comprise approximately 10%, isokinetic about 5%. (In some cases you can do a combination of isokinetic, isometric, eccentric, and concentric dynamic isometrics). All of these methods of training are typically done separately in individual training sessions.

However, it is also possible to do combined regimes. These have proven to be very effective, especially in the latter stages of developing maximum absolute strength, when you are preparing yourself for explosive training. For example, if you are executing a squat, have your assistants load 120 or more percent of your maximum concentric strength limit on your shoulders. Go down on your own effort until you hit the bottom position and hold for 4-5 seconds. Your assistants should then re- move the excessive weight from the barbell. You then rise up on your own power in the concentric regime but with the load below 100% of maximum.

Chapter Three
Physiological and Biomechanical Factors Involved in Plyometrics

Plyometrics applies to the display of explosiveness after quick, intensive loading of the muscles. This loading is necessary to pre-tense the muscle with greater force than can be volitionally generated and then using it in the main action. In other words, you make the muscle generate greater force, which can be used in execution of the skill to go further, faster, and higher. Keep in mind that the key element in sports today is speed and explosiveness.

To fully understand why plyometric training is so effective and why you should use it, it is necessary to more closely examine the relationships between them. To do this, we use a formula to show power, which is a term which can be used in place of explosiveness. In other words, the greater your explosiveness, the greater will be your power and vice versa.

In the formula we see that power (P) is equal to force (f) times distance (d) per unit of time (t): P = f x d. However, if we keep distance constant, we can substitute strength for force since the force comes from your strength. Therefore, the formula can be written: P=8, i.e., the greater the amount of strength that you can display in a certain period of time, the greater will be your explosiveness.

Thus, if you increase strength, power will also go up; if you increase speed and strength remains the same, then power will also increase. However, there is one drawback: If you keep increasing strength but execute the movement slower, the muscles begin to "learn" slowness and there will actually be a decrease in the amount of power that you exhibit.

The interrelationships between strength and speed can be seen by comparing several sports. In the sports of powerlifting, maximal weights are lifted regardless of the amount of time involved. In this case, strength is the main component. However, what occurs in the muscles can still be considered to be explosive. There is maximal recruitment of the muscle fibers and maximal frequency of firing the fibers to display

maximal strength. Thus, we can say that there is explosion within the muscle but not within the movement.

In the sport of weightlifting, maximal weights are also used but there must also be maximum speed, coupled with the strength. Thus, for maximum results you must develop increased strength, together with increased speed or an increase in strength with speed remaining constant.

In throwing a baseball, we utilize a very light object but it must be propelled with maximum speed. In this case, strength is not as important as speed, although keep in mind that with an increase in strength there can also be an increase in speed but only up to a certain point.

Let's examine in greater detail the mechanisms involved in plyometrics to develop explosiveness. First, it is necessary to understand the different types of muscular contractions: Eccentric, isometric, and concentric. In the eccentric contraction, the length of the muscle increases as the muscle undergoes contraction. This type of contraction occurs when the outside force is greater than the force that is being generated by the muscle. Because of this, the outside force lengthens the muscles as the muscle maximally tries to reverse the movement but is unable. The eccentric contraction is sometimes known as a yielding type contraction, i.e., the muscle yields to the outside force and lengthens. Most athletes can eccentrically lower 40%-50% more weight than they can lift concentrically.

In the isometric contraction, the muscle contracts but there is no movement. There is some shortening of the muscle fibers but because the outside force is so great, it is not overcome and thus no movement occurs. The isometric contraction is also known as a static or holding type contraction. It should be noted that in this type of contraction the strength developed is 10-15% greater than can be generated in the concentric contraction.

In the concentric contraction, the muscle shortens when it contracts. In this case, you overcome an outside resistance (weight) and move it a certain distance as the muscle contracts and shortens to produce the movement. This is known as an overcoming regime, i.e., you overcome the weight being used.

In plyometrics the most important muscular contraction is the eccentric. It is involved in many different ways in many different sports. For example, it is involved in:

1. **Pre-tension of the muscle prior to a concentric contraction;**
2. **In a stopping action as when you are running and make a quick stop or in a jump down action in which the eccentric contraction holds you from collapsing;**
3. **In receiving a force, as, for example, a football line-man making contact with an opponent who comes at him or in the actions involved in catching a ball;**
4. **In a repelling action since it re-tenses the muscle prior to pushing an object away from you;**
5. **In "blocking" as in the javelin throw after the approach run. You plant your forward leg to stop horizontal movement and allow the horizontally developed forces to move up into the upper body and then the javelin. Other examples can be seen in the high jump when you plant the push-off leg and in vaulting in gymnastics when you hit the take-off board;**
6. **In strength gains. It is a very effective way of developing strength by itself or in conjunction with the other muscle contraction regimes. In fact, the eccentric contraction creates the greatest amount of electrical activity, more than the other two types of muscle contractions.**
7. **As already noted, in some cases the force can reach up to 50% more than in the concentric. The eccentric contraction also plays a great role in jumping, pushing, and throwing actions. For example, some recent Soviet studies have shown that in jumping movements your results are not limited by the maximum strength shown by the take-off leg extensors and spinal extensors, but by the strength that these muscles show during their stretching, i.e., during their work in the eccentric (yielding) regime.**

In essence, the jumpers execute their skills under the influence of a kinetic energy reserve, which is acquired during the run-up and at the start of the take-off in the so-called amortization stage. In amortization, there is some shock absorbing, which must take place when your foot first hits the ground and preparation for the following take-off by accumulating the energy of the hit.

The forces generated during the landing are significantly greater than during the push-off stage. Thus, the strength needed most by a jumper is not for extension of the

push-off leg, but to prevent excessive flexion of the hip and knee during amortization. If excess flexion of the support leg in this stage is prevented, then the final phase of the take-off, the push-off, is executed successfully.

The reason for this is that in this phase the external forces acting on the juniper's body are substantially decreased and the extensors begin to contract and return to their initial state just as all elastic bodies do. Keep in mind that the muscles are very elastic and resilient and when they are stretched and tensed, they exhibit great forces to return to the original state.

Thus, the key in plyometrics is to get a maximum eccentric contraction, which develops maximal tensing of the muscle, and then to have the central nervous system switch this contraction to concentric, which produces the desired movement. Keep in mind that the force developed during the eccentric contraction is greater than what can be generated volitionally.

As mentioned previously, in a volitional contraction it takes approximately six to eight tenths of a second to achieve a maximal contraction. However, in sports the entire skill is accomplished in most cases between one and two tenths of a second. For example, a sprinter has his foot in contact with the ground for only one tenth of a second. A high jumper using the Fosbury type technique has his foot in contact with the ground approximately two tenths of a second. Thus, the key to get a maximally explosive push-off is to have the muscles respond with maximal force in the shortest amount of time. This can only be done by first getting a strong eccentric contraction, which must then be converted to a concentric contraction in the shortest amount of time.

Exactly what happens during a landing and take-off can be described by a rubber ball falling under the influence of gravity. At the moment of hitting the ground it flattens out somewhat due to its elasticity. Then it instantaneously takes on its former spherical form and bounces up. The height of the rebound depends not only on the level from which the ball was dropped, but also on the resiliency of the ball. A steel ball will rebound higher from a cement floor than a rubber ball. In other words, the greater the resiliency of the material, then the more effective will be the utilization of the kinetic energy accumulated in the fall for the lift of the body upwards.

In the body, the ball is replaced by the extensor muscles, which act as resilient cords. Thus, when jumping from a height, your legs (knees, hips and ankles) will, at the moment of landing, bend and stretch the resilient cords (muscles) of the respective joints. After some of the force of the landing action is absorbed by the eccentric contraction, the resilient muscles, in using the remaining force, will make you jump upwards. This is a very simplified view but it shows what happens when we execute a plyometric type exercise, especially in one of the methods called depth jumping.

However, a few words must be said about the landing and the amount of flexion that takes place in the joints at this moment. If there is great flexion of the ankle, knee, and hip joints, the body will be in a very unfavorable anatomical position for work. If you want to become close to being like a resilient ball and to jump higher after landing, then you must withstand the load at the moment of landing with as little flexion of the joints as possible.

When there is great flexion of the legs because of too much landing force, it increases the time you spend on the ground and most of the forces are absorbed. Thus the muscles undergo very little pre-loading or tensing.

You can test the role of a jump down from taking a test by yourself very easily. Execute a standing jump upward and measure how high you jumped. Then take a step, jump on both feet, and follow it with a take-off upward. You will jump significantly higher than the previous stationary jump. This is due to the kinetic energy you've accumulated in the initial step, which creates greater power and speed of muscular work at the moment of take off.

Also involved is stretching of the muscles. It is well known from physiology that because the muscle possesses great elasticity, when it is stretched it will contract more forcefully and faster due to the tension ensuing from the stretching. This is known as the myotonic reflex. The quicker and stronger the stretch, the greater will be the following muscle contraction.

Thus, the key to developing explosive force, which is the main outcome from doing various forms of plyometrics, is the switch from the eccentric contraction to the concentric. This is controlled by the nervous system and because of this, a good portion of the training is directed to nervous system training, not just the muscles.

By having prior tensing of the muscle, there are a greater number of motor units involved in the contraction and the impulse frequency, the rate at which they are fired, is greater. In addition, through nervous system action there is greater synchronization of all the muscles involved and maximum mobilization of muscle fiber recruitment. Thus, in explosiveness there is simultaneous starting work of all the mechanisms involved in the muscle to elicit a maximal contraction in the shortest amount of time.

To further illustrate the eccentric-concentric concept, we can use the example of a runner. Picture a runner running at maximum speed. At the moment his foot hits the ground he has a tremendous amount of force in the landing, which comes from the horizontal momentum and from the weight of his body when it hits the ground. The amount of force at this time is much greater than body weight and the faster the running, the greater the amount of force generated at touch down.

Some of this force must be absorbed and so the ankle and knee undergo slight flexion. However, the amount of flexion is kept at a minimum since you want to withstand most of these forces and switch them into the push-off force quickly. Thus, as the flexion in the joints takes place, a strong eccentric contraction is elicited, which, when it becomes strong enough, stops the flexion. In the process, a great amount of tension is built up in the muscle.

At the moment maximum tension is developed, the central nervous system switches the eccentric contraction to a concentric and the push-off occurs. The total amount of time involved for this whole sequence is about one-tenth of a second (less in world class sprinters). The phase of amortization (shock absorbing) takes approximately .05 second and the actual push-off approximately .05 second. The key in this case is to have as little flexion and stretching of the muscles as possible but to have maximum tension. The same concept applies to all jumping events. This can be illustrated by the graph in Figure 1 (below).

In the throws, essentially the same mechanism is involved but you go through a greater range of motion and you have more body parts involved. For example, in a typical throw you start off with one or more approach steps and then you plant your push-off leg, firmly controlled by a strong eccentric contraction to transfer your

horizontal speed to your upper body so that it can be used in the final stages of the throw.

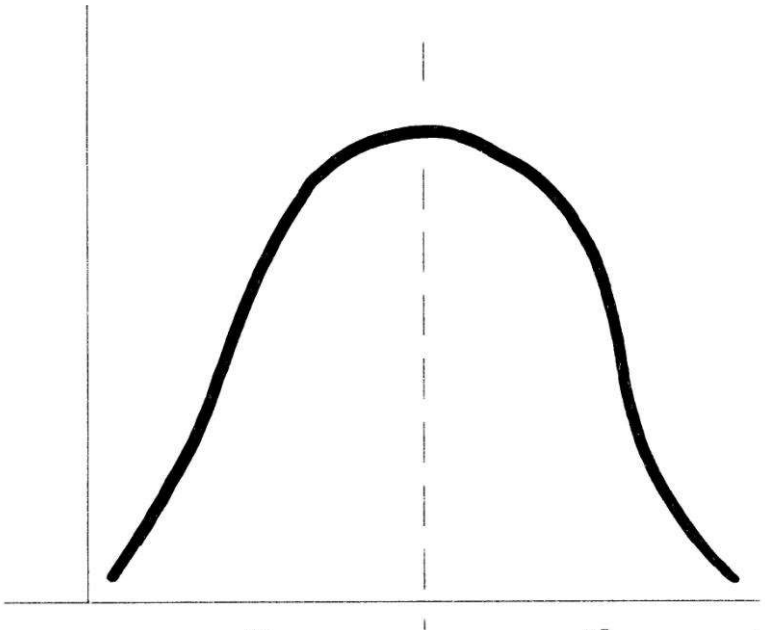


Figure 1

In planting your forward leg, the pelvic girdle remains facing mostly sideways. In this position, the medial rotators of the hip joint are put on stretch and under-go an eccentric contraction as the leg extensor muscles undergo an isometric contraction to hold a stable position. After the stretching of the hip joint medial rotators, the pelvic girdle is pulled around into a front facing position but the shoulders remain back so that the rotational muscles of the abdominal wall are maximally stretched through their full range of motion. Because of this action, they undergo eccentric contraction and when the tension builds up sufficiently, they switch to concentric and pull the shoulders around.

As this action occurs, the medial rotators of the shoulder joint undergo stretch in preparation for bringing the forearm forward. As the medial rotators undergo strong concentric contraction, the hand is whipped forward and in the process, the wrist joint flexors undergo eccentric contraction in preparation for flexion and hand pronation, which occur as the object is released.

Thus, in throwing there is a sequence of events that occur and the amount of force built up in each action is transferred to the next adjacent joint in the chain of events. Each involved muscle undergoes eccentric-concentric contraction to produce maximal speed of movement of each body part.

Although the stretch of the muscle occurs through a greater range of motion than that seen in a jumping type activity, the actions are executed very quickly so that as soon as the muscle is stretched it undergoes maximum tensing. In throwing, the initial concentric contraction is literally an "explosion" of the muscle and the remaining movement through the range of motion is ballistic, i.e., movement occurs on inertia. It is not due to a muscle contraction pulling the limb through the full range.

It takes many years to develop explosive power and as far as can be determined, it is not inherited. In order to develop explosive power you must train correctly. For example, a beginning athlete develops explosive strength in a manner depicted in the graph in Figure 2 (below). Note that the amount of force is low and that it takes a long period of time for maximal force to be developed.

For an intermediate athlete, the amount of force is greater and the amount of time taken for development of this force is shorter.

For an advanced athlete, the amount of time is shorter yet and the amount of force generated is much greater. Also note that the angle of rise on the curve is much steeper. This shows that maximum force is developed very quickly. In addition, you do not see flattening out of the curve at the beginning. It is almost a straight line directly upward. This indicates very fast starting strength, and high explosive strength.

Keep in mind that explosiveness is made up of two factors: Speed and strength. An increase in any one of these factors or both will lead to greater explosiveness and plyometrics can be adjusted to develop one or the other or both. These methods will be brought out in the following chapters.

Main Characteristics of the Ability to Display Power

A = Acceleration strength

I = Explosive strength (impulse frequency) = Fmax / Tmax

P = Absolute strength

Q = Starting force (strength, or, number of fibers involved at moment of impulse)

R = Index of reactive ability (average divided by body weight X time in execution)

B = Force required to overcome bodyweight

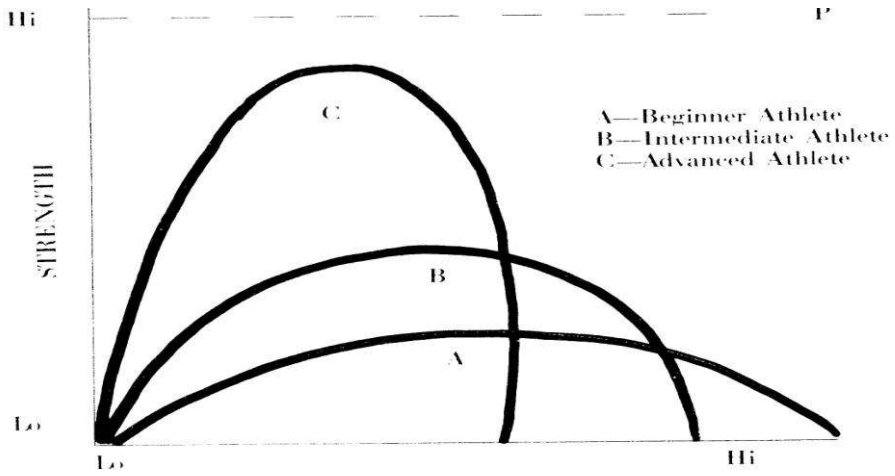


Figure 2

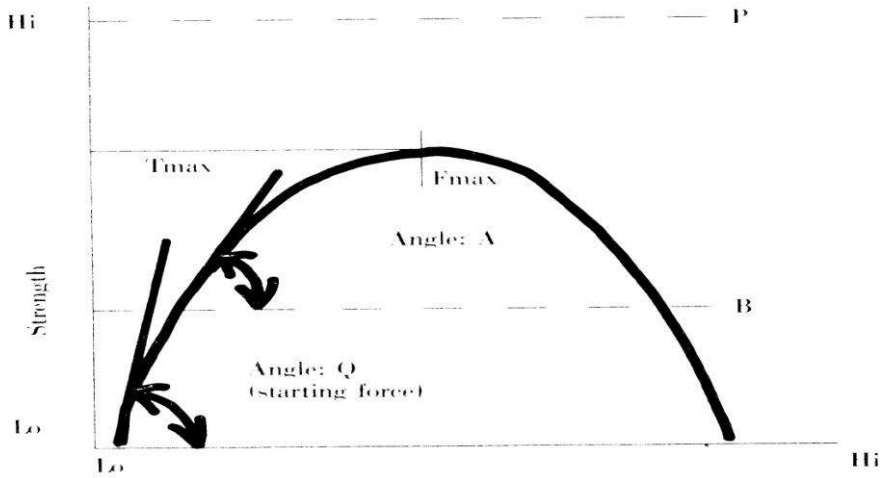
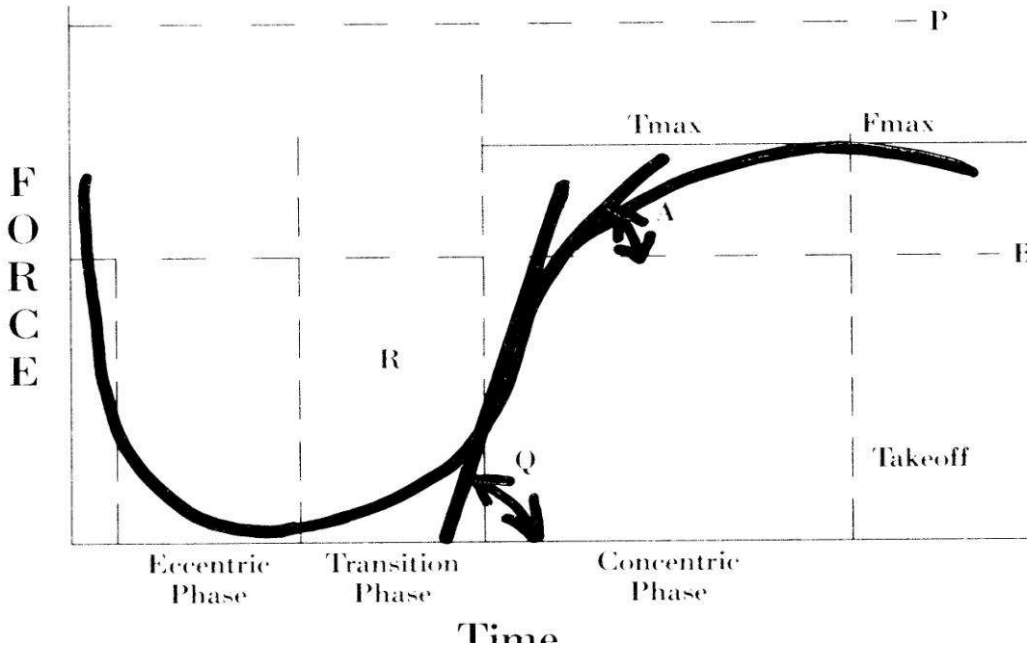


Figure 3

Example: Long Jump Takeoff



Chapter Four

Methods of Plyometric Training

Before undertaking serious plyometric training, it is important that you first develop a strength base. Since the force developed in some types of explosive training can reach 20 times your body weight, it is easy to see why you must be strong enough to withstand such forces. This means that you must develop concentric, eccentric, and isometric strength since all three of these muscle exercise regimes are used in plyometrics (explosive training). For a detailed discussion on the importance of strength in sports, and its relationship to plyometric training, refer to Chapter Two.

Thus, before undertaking training you should go on an all-round total body conditioning program. You should do exercises to develop all the muscles of the body and all the joints in all of their actions. This type of training should last between 1-3 months, depending upon your initial level of fitness. Once this general base is well developed, you should then begin to do strength exercises which more closely duplicate the actual movements involved in your sport, including plyometrics. The more specific the exercises, the greater will be the effectiveness of your workouts.

The development of explosive strength is more complex, and four methods are used. They are: 1) exercises with weights; 2) jump exercises (which up to this time have comprised the more popular concept of plyometric training); 3) the hit (shock) method; and 4) specialized equipment.

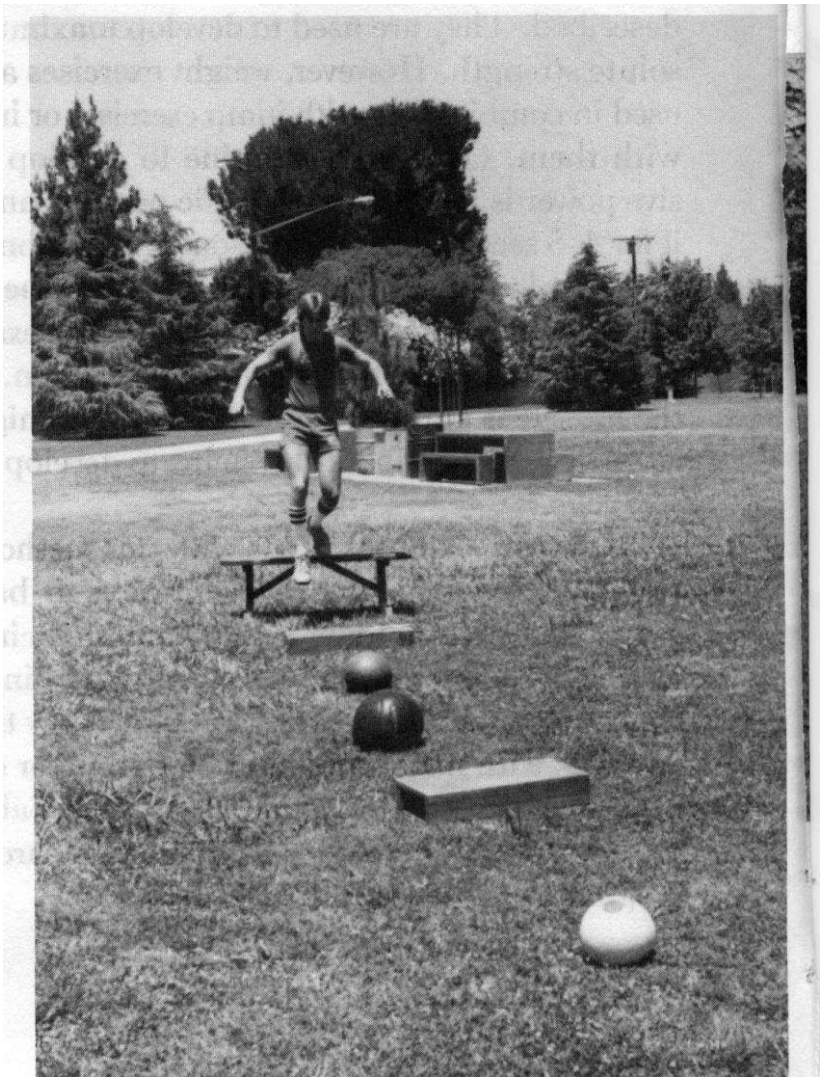
Exercises with weights

The exercises with weights have already been described. They are used to develop maximum absolute strength. However, weight exercises are also used in combination with jump exercises or in series with them. One simple routine to develop explosive power is to assume a specific position and hold it for 4-5 seconds to develop isometric tension. Once the muscle is prepared, you explode in the opposite direction with maximum speed. For example, go into a squat and hold the bottom position. When the muscle is amply prepared, leap up as high and as quickly as possible. This helps to develop explosive legs.

To develop explosive arms with this method, you can do an exercise such as lying on your back on a narrow bench holding a weighted medicine ball in your hands with the ball almost touching your chest. Hold for 4-5 seconds and then throw the ball upwards with maximum force. A barbell or dumbbells may be used instead of the medicine ball, with the obvious exception that you won't throw the weights.

Jump exercises

Jump exercises are the simplest form of plyometrics. The jumps are usually done in series of approximately 10 jumps. They can be done on both legs or on single legs or alternating between legs. However, when first beginning you should always do double leg jumps up until your legs (or arms) become accustomed to the jumping. Keep in mind that the amount of eccentric force generated in a single leg jump is about twice that of a double leg jump and if your muscles are not prepared for this force, it may be injurious.



Next in progression are a series of jumps having different directions, jumping over various objects and jumping onto and off various objects. For example, you can jump sideways, then forward, and then backward. Or you can jump in a zigzag fashion. It is also possible to jump with body turns so that you end up facing in different directions after you execute the jump. All body turns are made while you are airborne.

Jumping over objects becomes more effective than simple jumping because it forces you to jump a little higher, which, in turn, creates greater force upon the landing. This, in turn, allows for greater development, which, in time, allows you to jump even higher. Also, by jumping onto and off various objects it puts more variety into the program as well as exposing your nervous system to experience different amounts of force from the different jumps. This also provides for greater development.

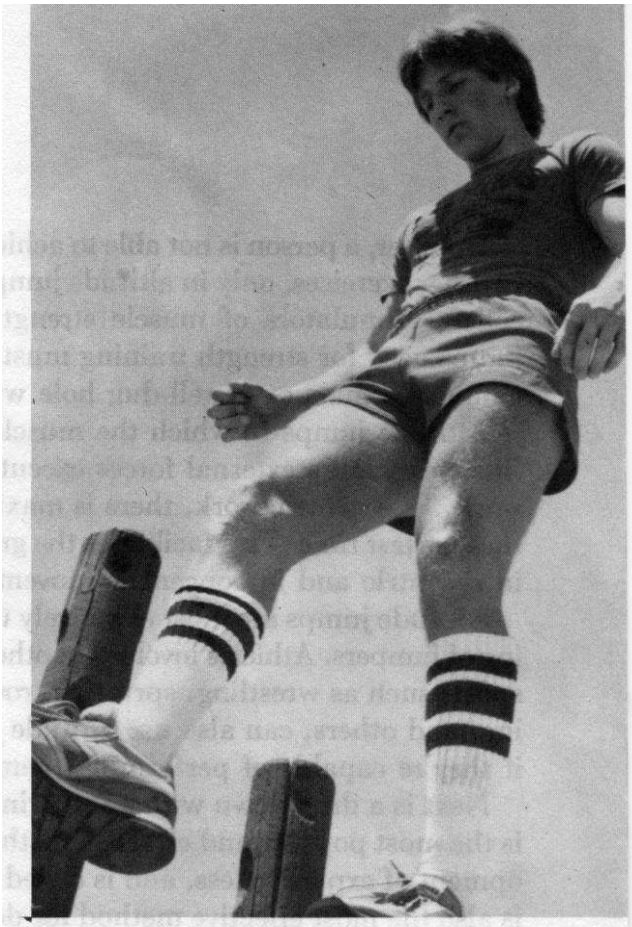
The hit (shock) method

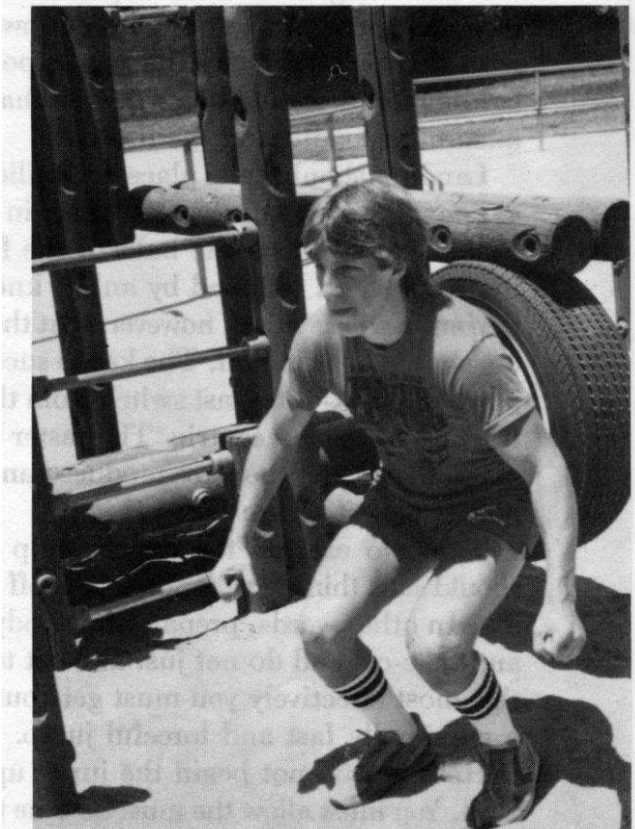
Next in the progression are altitude jumps, a term coined by Fred Wilt, which are an example of the hit or shock method. In essence, you step off from various heights and upon landing you undergo minimal flexion of the legs (or arms) which forces the muscle to stretch sharply and undergo maximum tension. Keep in mind that this happens automatically and your mind is not involved in developing maximum tension. This is why this method is so effective. It produces a greater force than you could produce volitionally.

In general, for highly trained athletes with great absolute strength, the altitude jumps are done from a height of approximately 5-6' and more. However, when first beginning you should begin with low heights of approximately 2-3' and gradually work up to 6' or more. Studies have shown that jumping off from heights of 9' or more are counterproductive and the athletes are hesitant to jump from such heights.

The main reason for using altitude jumps is to develop super-maximal strength, i.e., maximal eccentric strength. To do this, it is necessary to use exercises in which the muscles are forced, under the influence of significant external forces, to execute work in the eccentric range. The load must be such that it forces the muscles to contract at the upper limit of their super-maximal strength for a very brief period of time.

In the altitude jump, upon landing from a height of 6-7', the extensors of the ankle, knee and hip joints and the spine are forced to execute eccentric work under the





influence of inertial forces. In these brief conditions the athlete develops the ability to display brief (in the range of 0.037- 0.061 second) muscle tension during which the force reaches values that are fantastic at first glance. It fluctuates from 1500 - 3500kg, i.e., they exceed your weight by 20 or more times. These values are achieved for a period of from 0.028 - 0.065 second.

However, a person is not able to achieve such strength in other exercises, only in altitude jumps, which are excellent stimulators of muscle strength. The altitude jumps used for strength training must be done on soft gymnastic mats or a well-dug hole with sand.

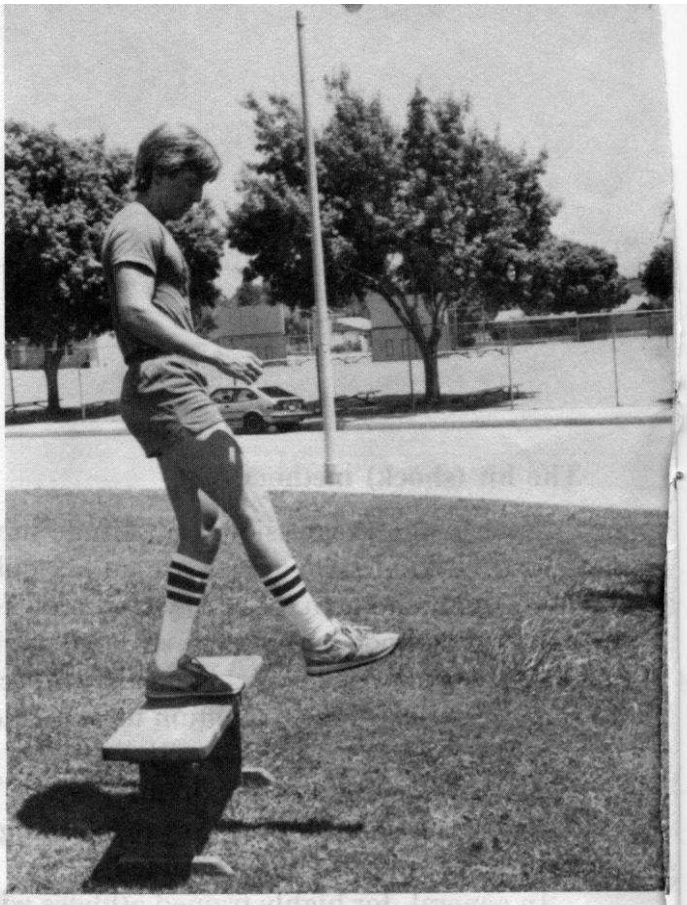
Altitude jumps in which the muscles under the influence of large external forces execute only eccentric work. In eccentric work, there is maximum tension in the shortest time. This facilitates the growth of strength in eccentric and in concentric movements.

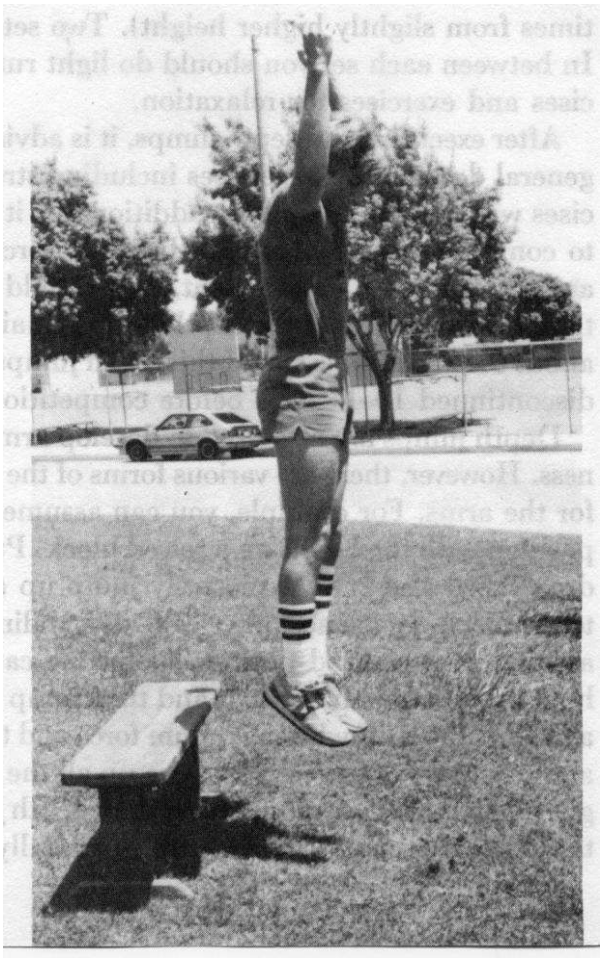
Altitude jumps are most effectively used in the training of jumpers. Athletes involved in other speed-strength sports such as wrestling, sprinting, rowing, weightlifting, and others, can also use altitude jumps, but only if they're capable of performing them well.

Next is a drop down with a following jump up. This is the most popular and effective method for the development of explosiveness, and is called depth jumps. It is also the most effective method for developing the reactive ability of your neuromuscular system. When the muscle is stretched, it develops elastic strength. This is not a metabolic process, it is purely physical.

To execute depth jumps, you step off a box or bench set at a certain height so that you drop straight down (not at an angle). As soon as you hit the floor, you immediately jump straight upward or upward and forward, with as little bending of the legs as possible. All of the landing forces should be vertical so that they can create maximum loading on the muscles.

Landing should take place on resilient mats such as gymnastic or wrestling mats. Also, in the landing you should land first on the balls of the feet and then on the whole foot, followed by ankle, knee, and hip joint flexion. Keep in mind, however, that the





amount of flexion should be minimal. The key to success in the depth jump is a maximum fast switch from the eccentric contraction to the concentric. The faster the switch takes place, the greater the force produced and the greater will be the height of the take-off.

Thus, to execute the depth jump explosively, you should start thinking about the take-off prior to the landing. In other words, prepare your body for the landing and take-off and do not just allow it to happen. To do this most effectively you must get yourself psyched for a maximally fast and forceful jump.

However, do not begin the jump up until after you land. You must allow the muscles time to sharply stretch and tense.

The most effective height for the depth jump is between 30 - 40 inches. However, when first starting you should use a lower height until you get used to the mechanics of the depth jump. When your muscles are prepared, then go to a height between 30 - 40

inches. As a general rule-of-thumb, your depth jump height should be no more than a foot above your vertical jumping ability.

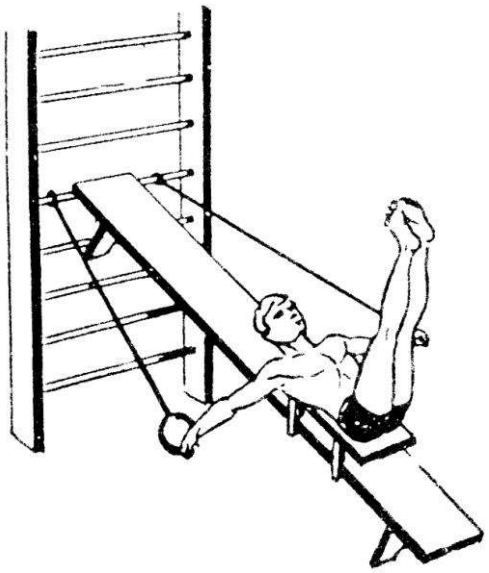
At a height of 30 - 40 inches, the amount of speed and strength is well balanced and you get the maximum effect of both of these physical qualities. If you increase the height from which you step off, then you would rely more on the strength component and if you lower the height, you will rely more on the speed component. Thus, by adjusting the height of the depth jump you can variably improve more strength or speed.

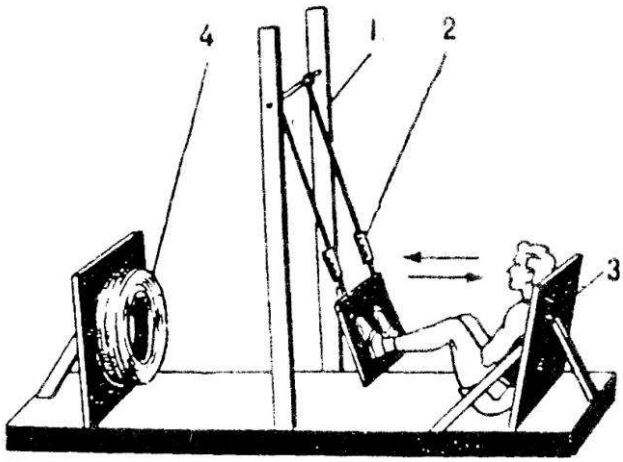
Depth jumping from too high a height typically happens with beginning and intermediate athletes who usually function on the principle that 'if I do more, it will be better.' Because of this, they increase the height to amounts that are beyond their capabilities to execute the jump effectively. When you jump from too high a height, there is too much flexion in the legs, which absorb most of the force of the landing, and thus there is very little force to propel you upward. You thus end up with a weaker and lower jump. Jumping from too high a height also involves different take off mechanisms.

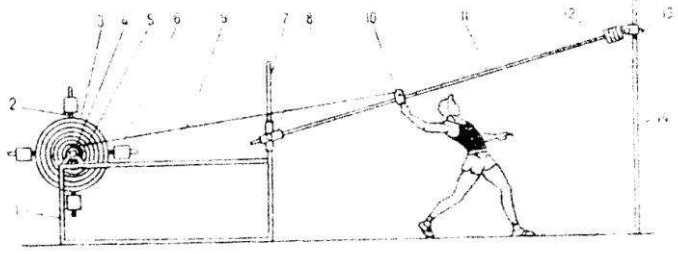
It is also important to keep in mind that it is most advantageous to execute depth jumps after adequate strength preparation (preparatory period of training). Because of the great forces involved, it is necessary to begin doing such exercises very gradually. Practice has shown that in most cases you should be able to squat 2.5 times your body weight before undertaking maximum depth jumps.

How often you jump is also important. For athletes who are well prepared physically, doing depth jumps three times a week is usually sufficient for most sports. Also, the number of depth jumps in one session should not be greater than 40 times. For less physically prepared athletes, 20 - 30 repetitions of the jump one time per week is sufficient.

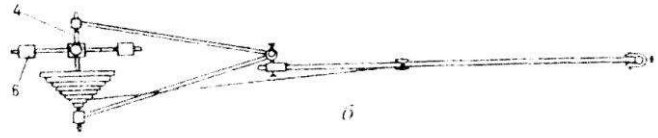
Although there is some variability, depth jumps are executed in series (10 times from a lower height and 10 times from slightly higher height). Two sets are done. In between each set you should do light running exercises and exercises for relaxation.







а



б

After executing the depth jumps, it is advisable to use general development exercises including strength exercises with moderate weight. Additionally, it is effective to combine these jumps with barbell exercises if they are not used to a great extent. You should also know that the after-effect of the depth jump is maintained for about 6 - 8 days. Because of this, such jumps should be discontinued 10 - 14 days before competition.

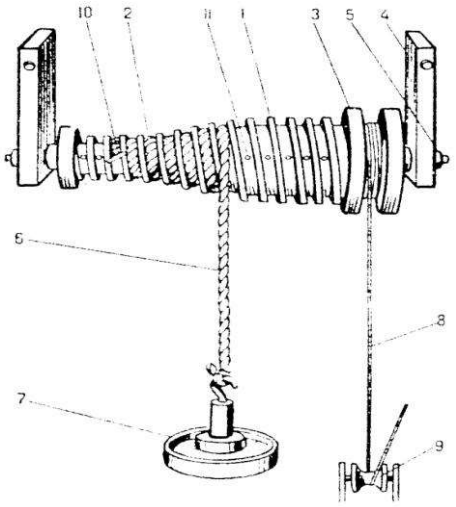
Depth jumps are also used to develop arm explosiveness. However, there are various forms of the hit method for the arms. For example, you can assume a push-up position with the hands on a raised block. Push off and drop down and then explosively jump up again back to the block. In its most physically demanding form you assume a handstand position (someone can help you hold this position if needed) and then jump down from a height. Push off with maximum force and then go into another jump or into a roll to use up all the extra energy. These jumps are more taxing than depth jumps with the legs. However, they are also maximally effective.

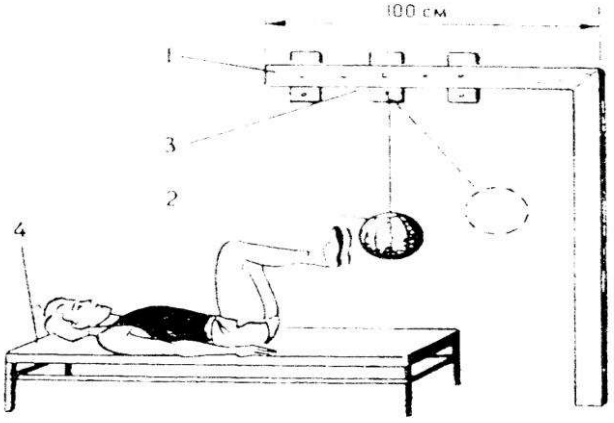
Special equipment

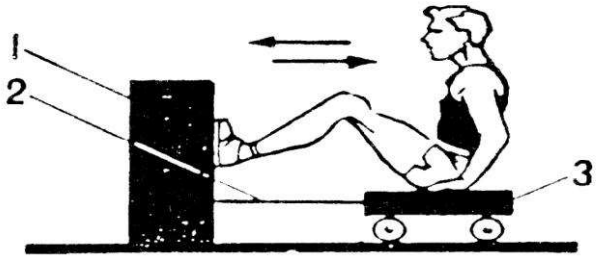
Next in the progression for the development of explosiveness is the use of specialized equipment. For example, to develop arm explosiveness you can use a pendulum type device. A weight is hung on a long lever which swings into you so that you "catch" it and then repel it with maximum force.

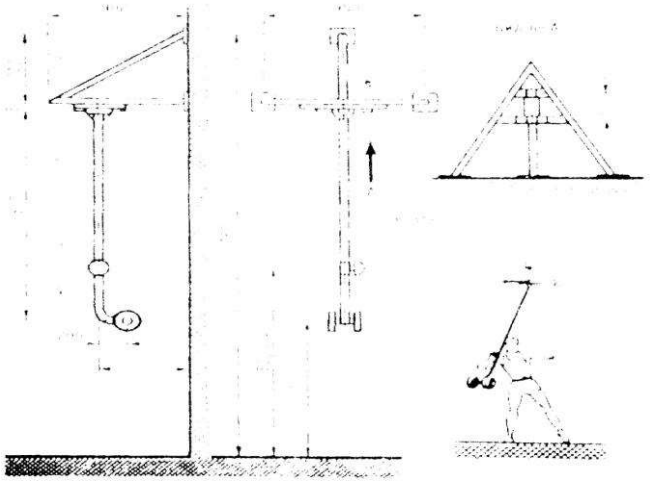
You can use medicine balls for catching and throwing in an analogous manner. You can vary the types of throws and the weight being used to develop arm and body explosiveness. In fact, you can do exercises that involve both leg explosiveness and arm explosiveness in one exercise. An example of this would be to leap out of a squat and throw a medicine ball with the arms simultaneously.

You can also use rails on which you can roll or slide while pushing or pulling in various ways. For example, you can sit in a sled-like seat and then slide down the rails until you hit a resilient surface with your legs. You then immediately explode to push yourself back upwards. The same can be done for the arms, but the angle in this case is much less severe so that the forces generated will not be injurious. You can also use dollies which are attached to elastic bands or springs. As you roll into a resilient surface, you push off with maximum force, which, in turn, stretches the elastic band.


10
2
1
3
5
4
6
8
7
9


100 см
1
3
2
4


1
2
3



When it shortens, it moves you back into the resilient surface with sufficient force to generate the tension needed to explosively propel yourself back.

One of the latest methods used by the Soviets that is increasing in popularity is the use of swings. In essence, you sit in a swing which is capable of being weighted on the sides. You swing into a resilient force plate and then explode maximally with the legs to push you away as far as possible. You then swing back into the object with a consequent explosive push off. The amount of force that you generate is dependent upon the amount of weight that you put on the swing as you swing into the object. These swings are being used with increasing frequency to determine the explosive power of various athletes.

The hit method is not reserved only for explosive legs or arms. With certain modifications it can be used in many different sports. For example, in hockey rather than using the usual weighted puck you use a weighted (heavier) puck in receiving and passing. The heavier weight of the puck creates additional force when it contacts your stick, which you must withstand and repel. The faster you can do this, the more explosive your shots will become.

The Soviets have developed several particularly interesting devices for improving the quality of plyometric training, and several are depicted here.

Chapter Five

Explosive Legs for All Sports

For development of explosive legs a similar progression is followed as outlined in Chapter 4. First, you must undergo an all-round strength training program to develop strength of the legs, midsection, and to a lesser extent, the upper body. Refer to Chapter Two for strength training information.

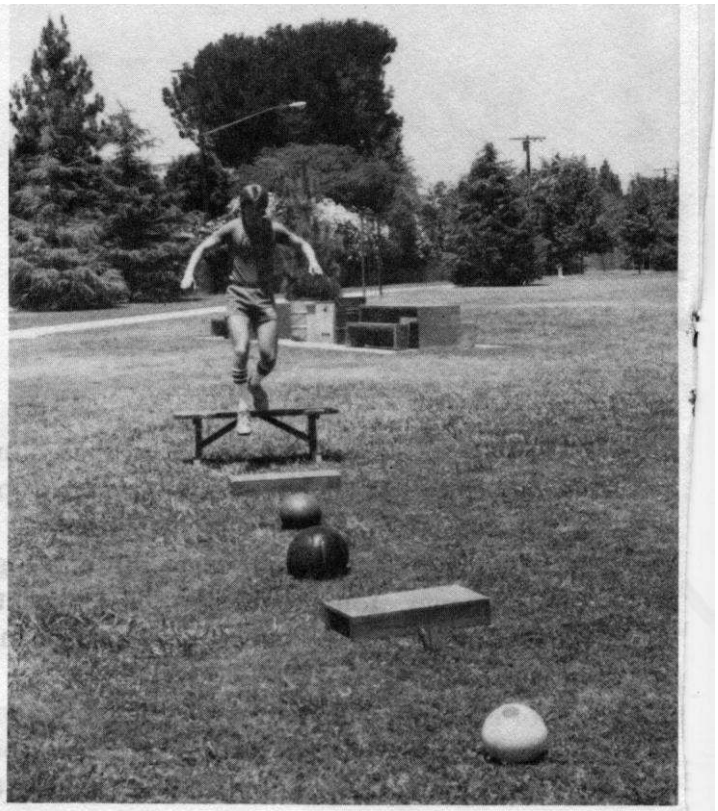
When doing all-round strength training for the legs, you should do heel raises, heel raises with a 2-4 inch block under the balls of the feet, knee extensions, front and back squats, lunges, leg presses (with the body in different positions on a incline board to accentuate either greater development of the hip extensors, hip and knee extensors, or only the knee extensors), and glute-ham-gastroc raises. If you are involved in a sport such as running, you should also develop the hip flexors by using specialized exercises. Start with your thigh behind the body so that the angle between your thigh and trunk is approximately 210 degrees.

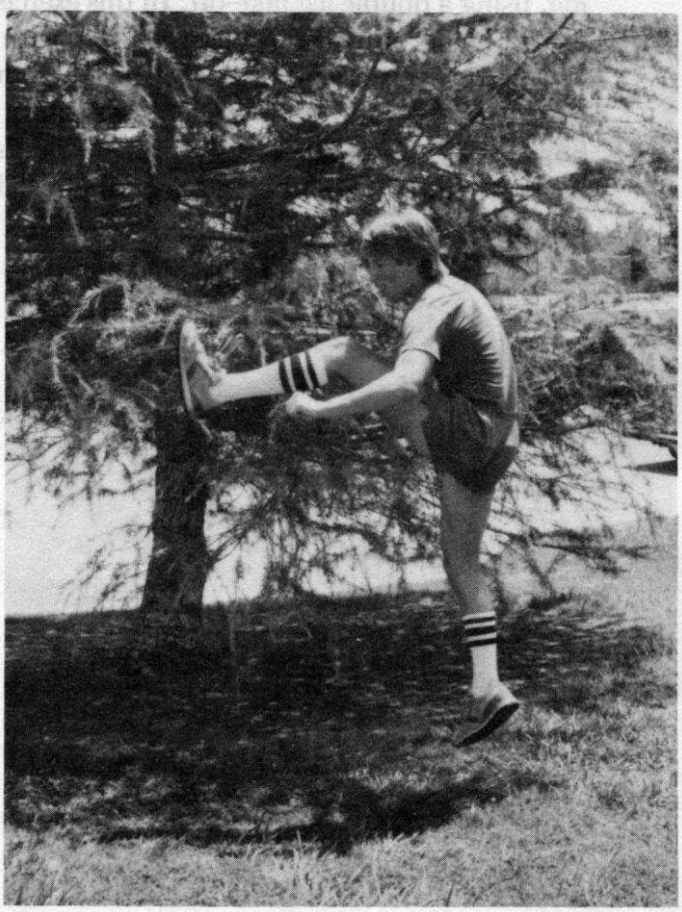
For the midsection you should do sit-ups, reverse sit-ups, reverse trunk twists, back raises, and good mornings. To improve the arm swing you should do front arm raises beginning with your arms behind your body.

You should then go into more specialized exercises such as the squat with three different muscle contraction regimes: 1) heel raises on an incline board, 2) squats with a rise up onto the toes and 3) combination exercises such as coming out of a squat with a dumbbell arm swing and heel raise with dumbbells in the hands and other similar type exercises.

You can also do isometric contraction holds in various positions of a squat, followed by an explosive movement upward. For example, if you're a jumper, assume positions that are close to the angle at which your legs are at during the take-off.

You can increase the intensity of these jumps by taking off from higher boxes or jumping up onto higher objects. You can also increase the intensity by increasing the distance or height of each jump, together with the frequency. You should make





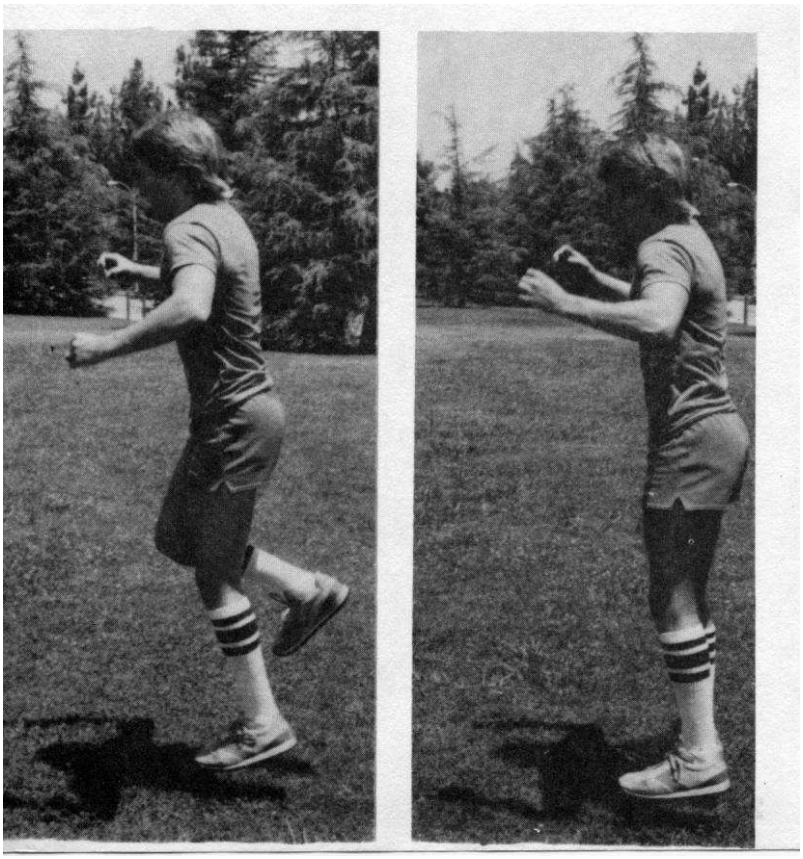
appropriate changes, depending upon the specifics of your sport and your level of competency.

For example, if you are a sprinter, you can do double leg and single leg hops. In these exercises you jump forward as quickly as possible, striving to keep the amount of time your feet are in contact with the ground as short as possible. If you are involved in sports such as volleyball and basketball, you do more stationary power jumping, using a double leg take-off. In this exercise you jump up as high as possible, reaching upward with your arms. If you are involved in a sport such as long jumping, then you can do bounding, which, in essence, is multiple hopping (like a kangaroo) for maximum distance. Use both a double leg and single leg take-off. Repeat 5-7 times.

In the initial position for the leg pull-through, stand with your back towards gymnastic wall bars (or a hurdle). Place the swing leg to the rear and secure the outside arch of the foot onto the bar of the gymnastic wall bar or hurdle. Keep the knee bent. Flex the hip joint. Hold for 6-8 seconds. Relax and repeat or reverse hold and swing forward. Some depth jumps may also be included at this time, but only from low heights.

As you execute some of the specialized strength work, you can also begin jumping, but at a moderate rate and without great intensity. Some of the more effective exercises are as follows:

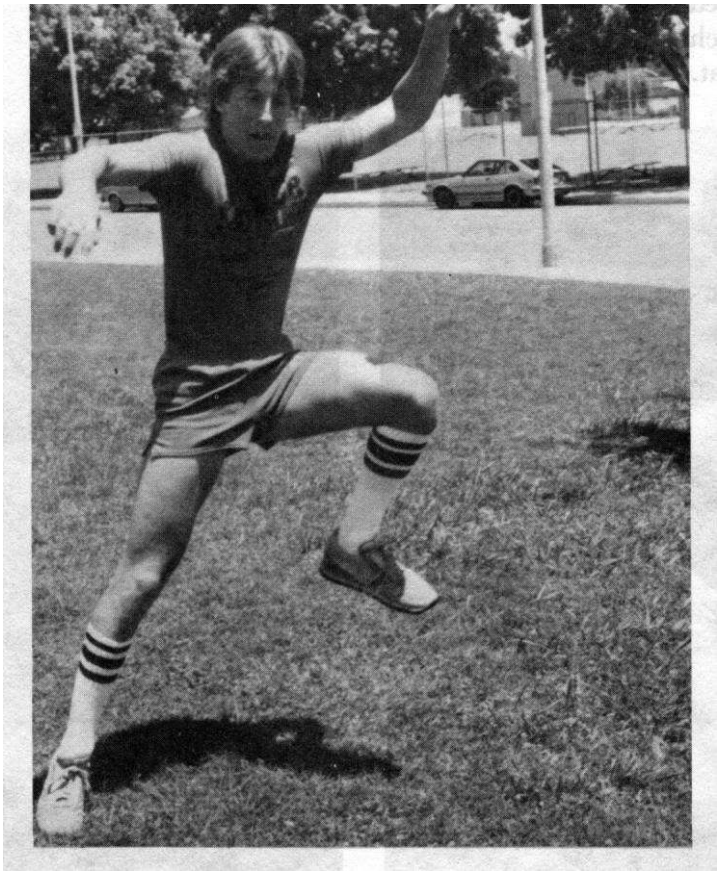
1. **Double leg hops in place (150-160 jumps per minute).**
2. **Double leg jumps over 6-8 medicine balls placed at suitable distances for jumping over. If you want more height, keep the balls closer; if you want more forward movement, place the balls further apart.**
3. **Jumps for height with an approach run, including kicking a hanging object.**
4. **Single leg jumps (hops) with forward movement.**
5. **Single leg hops over 6-8 medicine balls (low obstacles).**
6. **Skips (leap-hop).**
7. **Leaps (from one leg to the other up to 10).**
8. **Ankle jumps. The key is to keep your legs straight and use only ankles.**



After developing confidence in your ability to do these jump exercises, you can then begin doing some jumps with changing directions. Some of the exercises that you can do are as follows:

1. **Double leg hops forward. Prior to landing, turn 180° so that when you land you face the position you took of from. Leap up again and make another 180° turn to again face forward. You can change body position with each jump or after several.**
2. **Side jumps. Jump to the left and then to the right, staying in the same basic position. After you master this jump, go on to #3.**
3. **Side jumps over a medicine ball or other object.**
4. **Side jumps over a bench.**
5. **Zigzag jumps. Jump forward and to the left, then forward and to the right. Go for approximately 10 jumps. Repeat for 2-3 series.**
6. **Box jumps. Jump forward, to the right, to the rear and then to the left and repeat in the opposite direction. (Jump to each corner of a square traced on the ground).**

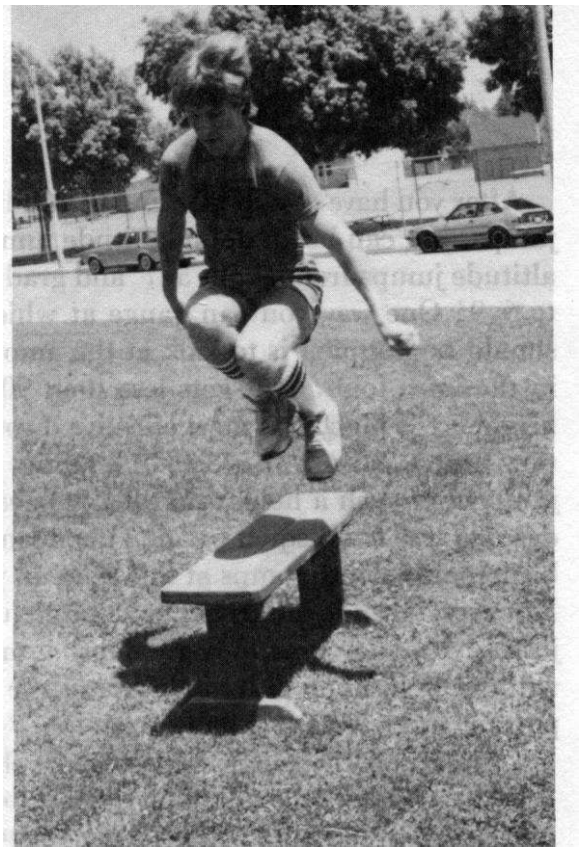
After you have confidence and the ability to do these jumps, you can begin doing altitude jumps. Begin the altitude jumps from about 5-7' and gradually work up to 6-9'.

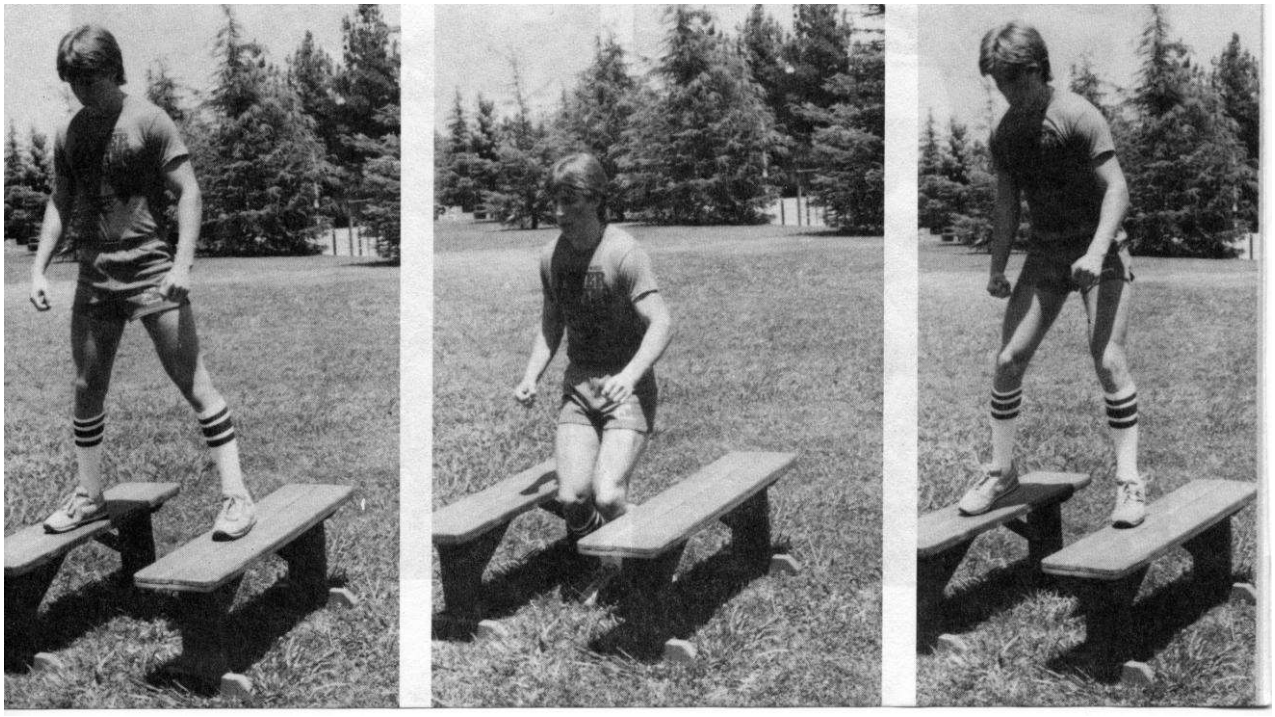


One way you can gauge at which height you should be jumping is to look at the amount of flexion in the knee joint. If it gets less than 90°, your jump height is too high. It is most effective if your knees bend very little to absorb the force of landing. You must not jump from such a height that it becomes necessary to descend into a full-squat position upon landing. You can begin doing depth jumps at this stage in your training. However, altitude jumps are not a prerequisite to depth jumps. You may wish to begin depth jumps right away without first doing altitude jumps. Here are some important guidelines for depth jumping:

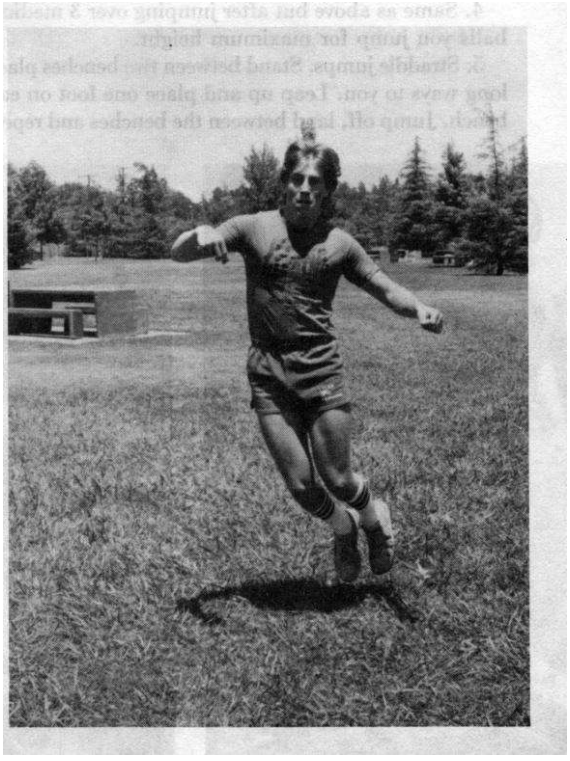
1. **Begin by stepping off a low box or chair and immediately after landing, jump upward for maximum height. Repeat 8-10 times for 2-3 sets. In time, gradually increase the height to between 30-40 inches.**
2. **Step off a box, drop down, jump up and over 6 medicine balls laid out in a row.**
3. **Same thing but only jump over 3 medicine balls and then jump over a low hurdle.**
4. **Same as above but after jumping over 3 medicine balls you jump for maximum height.**
5. **Straddle jumps. Stand between two benches placed long ways to you. Leap up and place one foot on each bench. Jump off, land between the benches and repeat.**

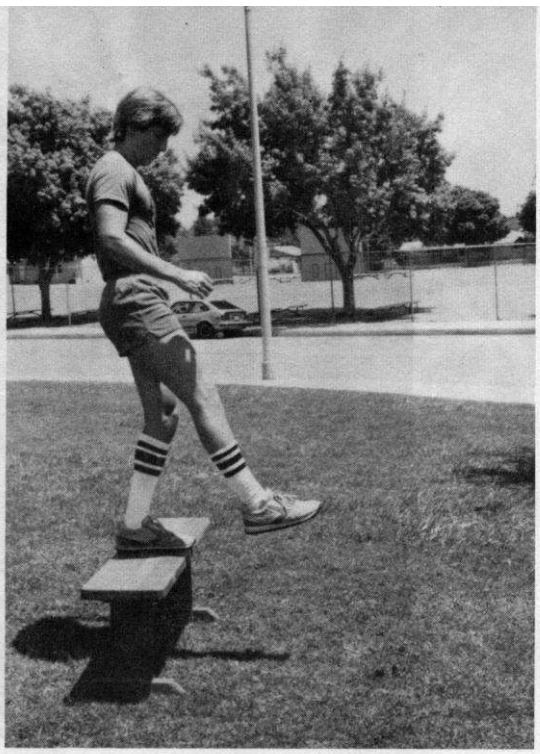
6. **When your muscles are strong enough, execute a depth jump with one leg. Step down and immediately upon landing jump up and over 3 medicine balls laid out in a row. Use the same leg or alternate.**
7. **Depth jumps with a jump up to another box. Jump off to the floor, then up to other boxes of the same height. When familiar with these jumps, try alternating the height of the boxes.**
8. **Do several side jumps over a bench, followed by several forward jumps over benches.**
9. **Same as #8. Add jumps onto higher objects for a total of 10-15 jumps.**
10. **Jump over a box but prior to landing turn your body 90 degrees so you land in a side facing position to the box. Execute 2-3 side jumps and then execute another 90° turn to land facing forward or backward.**
11. **Jump up to a box and then jump off the box as high as possible, reaching up to grab a hanging object and then land on the floor.**
12. **Single leg hop onto a box and single leg hop off onto the floor, followed by another jump on and off.**
13. **Stair jumps. Do forward and/or side jumps, taking 2-3 stairs at a time and move upwards as fast as possible.**

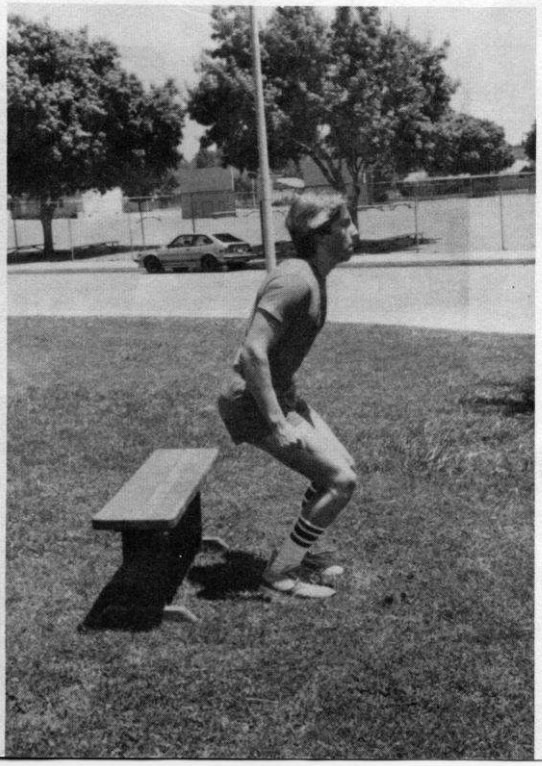


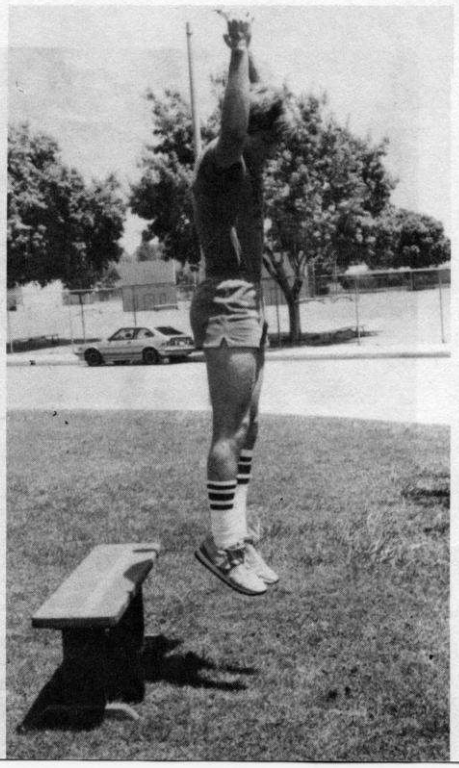


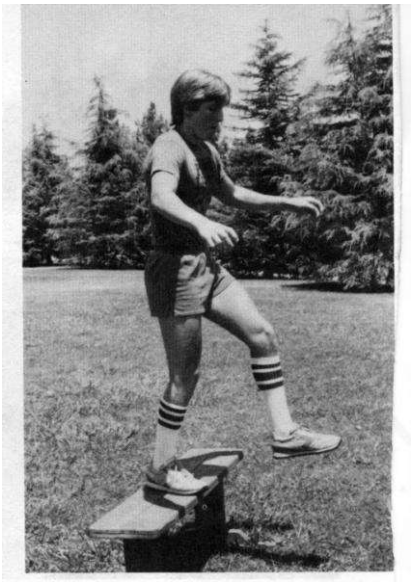
Jump exercises with weights can also be done at this time (and some even earlier). For example, hold dumbbells in the hands and do squat jumps for 8-10 repetitions, 2-3 sets. You can also do split squat jumps with or without dumbbells in the hands or barbell on the shoulders. The key in these two exercises is to jump as quickly and as high as possible. If holding the weights in the hands or on the shoulders is not comfortable you can hang weights on the waist or wear a weighted belt.

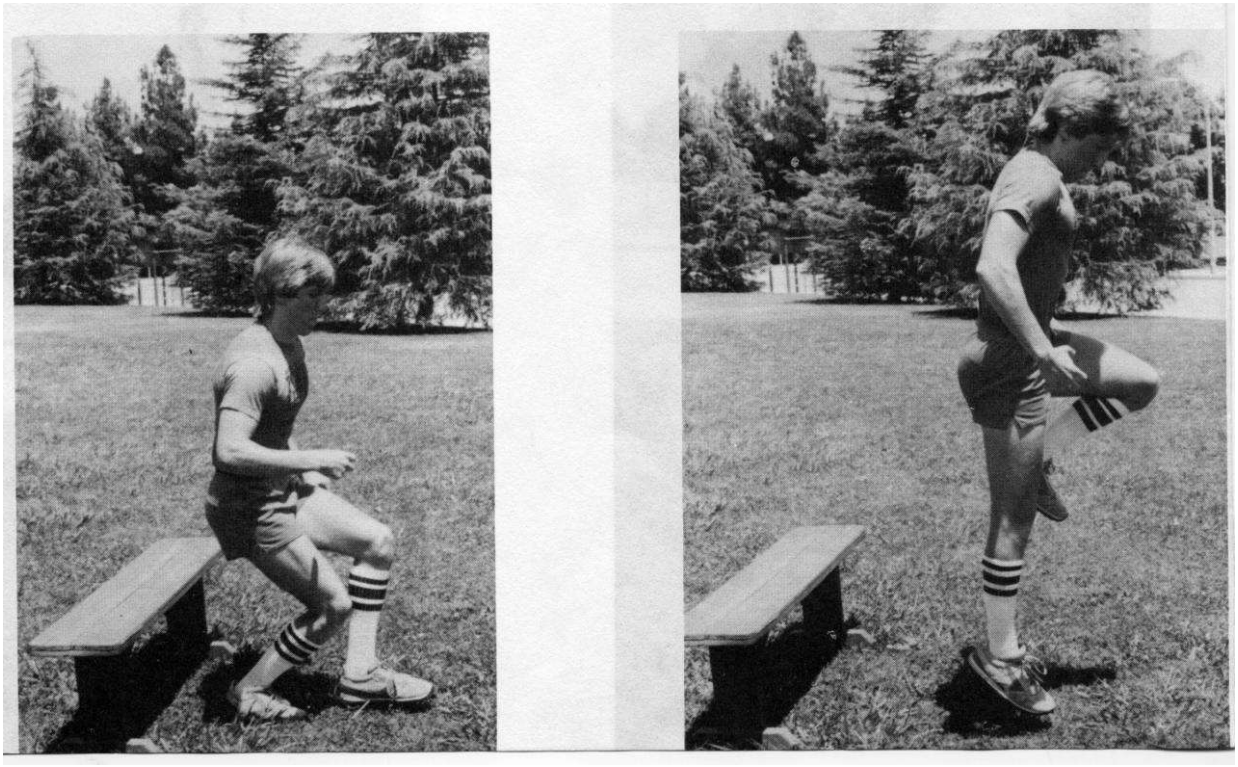












If you are involved in the long jump or high jump, you can execute 5-7 take-offs while moving forward, imitating the take-off in the long jump or the high jump.

If you are a sprinter and wish to improve running speed for a short distance of up to 40 yards (or a football player who is tested in this event), you can do short fast jumps with the take-off on one or both legs and variants of the triple and quintuple jumps from place. In the "short" jumps the exercises are executed with maximum take-off power.

If you wish to increase running speed over a longer distance, as for example over 100m, then you should do "long jumps" which involve multiple take-offs on one leg or from leg to leg for distances of 30, 60, and 100m and more. Emphasis is on maximum speed of movement or maintaining maximum power take-offs with repetitions.

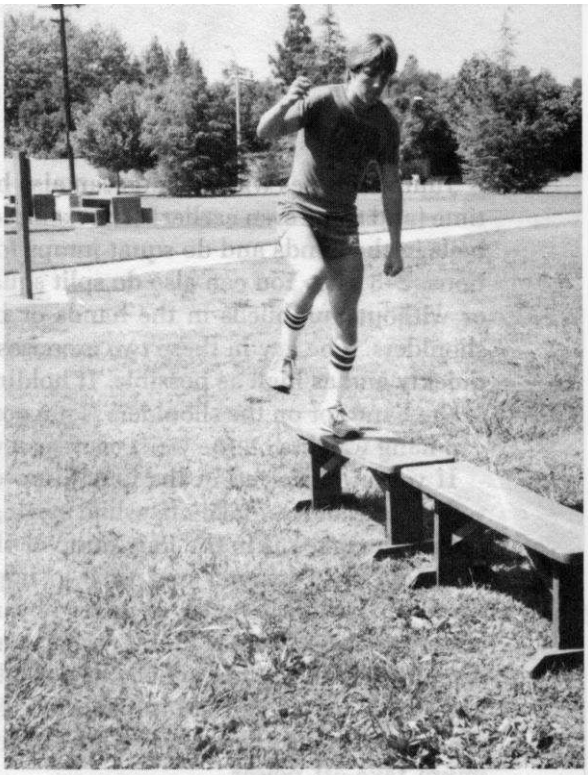
Soviet research has shown that the "short" jumps substantially improve running speed for short distances up to 40 yards. Long jumps help to improve running speed in longer distances and also on shorter distances started from a walk. In the short jumps you have the ability to improve starting acceleration while in the "long" jumps you raise the level of specialized speed-strength endurance and maximum running speed.

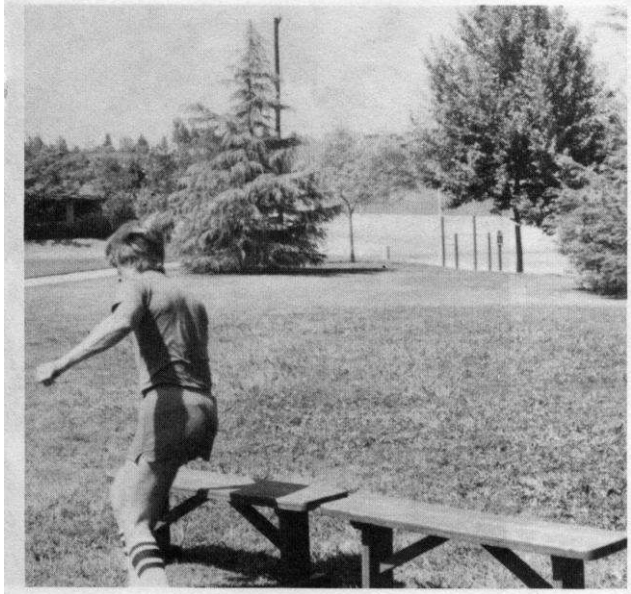
If you wish to develop both starting acceleration and your level of speed-strength endurance, you should do both long and short jump exercises. If doing both short and long jump exercises in one session, the "short" jumps should precede the "long" jumps.

In executing the jump exercises to improve sprinting speed, the lower leg should move forward smoothly and the landing should be on the ball of the foot. It should not be a hitting placement, but instead the foot should be placed on the ground resiliently and immediately begin with a pawing action. The jumps are executed on a low trajectory with arm action synchronized with the leg movement.

If you are a long jumper, you can do the following exercises:

1. **Stand on a box about 30 inches high and keep the swing leg in front and the push-off leg behind. Jump off with the take-off foot with a following long jump. Do on each leg 7-8 times. Accent is on coordination of the work between the take-off and swing legs. Execution is in a fast tempo.**
2. **In the initial position the take-off leg is in front, the swing leg behind on the ball of the foot. From 3-4 running strides, execute a fast take-off with the following consecutiveness: Ground, take-off board, box (40cm), onto a horse reaching a hung object with the hand. Execute 3-4 times. Shoulders should not be caved in. Execute in a moderate to fast tempo.**





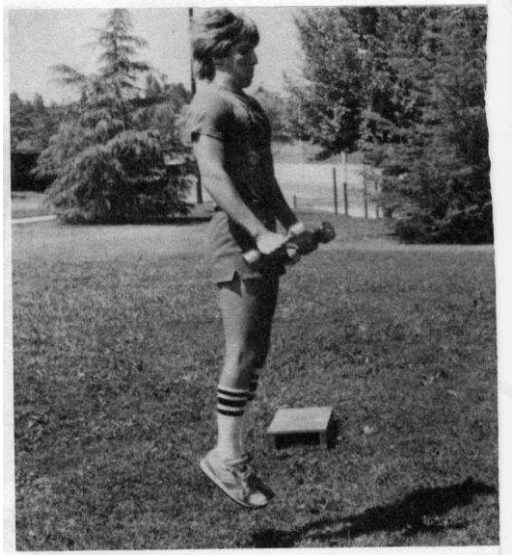
3. **Lunge with the bent foot forward and the other leg behind slightly bent. Hold dumbbells of 10-20 pounds in the hands. After 3-4 springy "bounces" switch the position of the legs with a jump. Execute 6-8 times at a moderate tempo. In executing the exercise, the trunk is straight and arms should be held freely.**
4. **Exercises with equipment can also be used to develop explosiveness for the legs. For example, you can do medicine ball catches and throws with the legs. Assume a back lying position with the knees bent and with the feet up and facing away. Have a partner throw a ball to you that you "catch" with your feet in a receiving action and then quickly repel the ball in an explosive action. Start off with light balls and gradually work up to heavier ones, as long as there is no excessive knee joint flexion. Also, you can lie on your back in front of the suspended medicine ball. Push the ball away with your feet and as it swings back to you, catch and repel it again. Do up to 10 repetitions.**

Special equipment can also be used. For example, you can sit in a swing and as you come forward, come up against a board which is cushioned by a rubber tire and immediately push yourself backward and then swing into the board again. Repeat 5-8 times.

In addition, you can use incline sleds and weighted swings with contact made against a resilient surface or a force platform. The force platform can be used to measure the amount of force you are generating in the hits and in push-off or it can be used strictly as a training device.

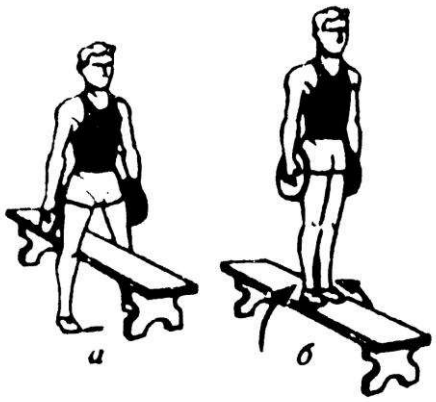
Exercises with equipment can also be used to develop explosiveness for the legs. For example, you can do medicine ball catches and throws with the legs. Assume a back lying position with the knees bent and with the feet up and facing away. Have a partner throw a ball to you that you "catch" with your feet in a receiving action and then quickly repel the ball in an explosive action. Start off with light balls and gradually work up to heavier ones, as long as there is no excessive knee joint flexion. Also, you can lie on your back in front of a suspended medicine ball. Push the ball away with your feet and as it swings back to you, catch and repel it again. Do up to 10 repetitions.

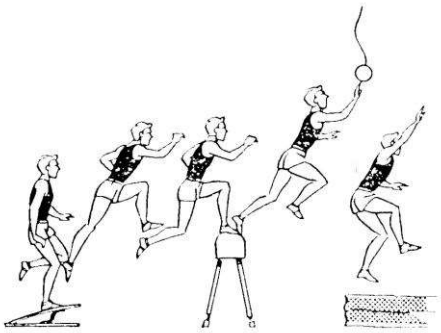
Special equipment can also be used. For example, you can sit in a swing and as you come forward, come up against a board which is cushioned by a rubber tire and

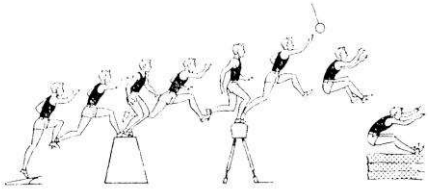


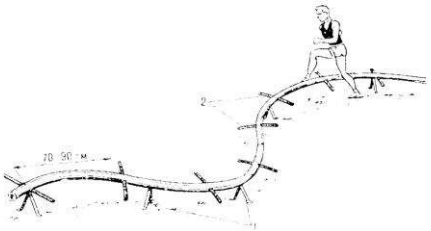
immediately push yourself backward and then swing into the board again. Repeat 5-8 times.

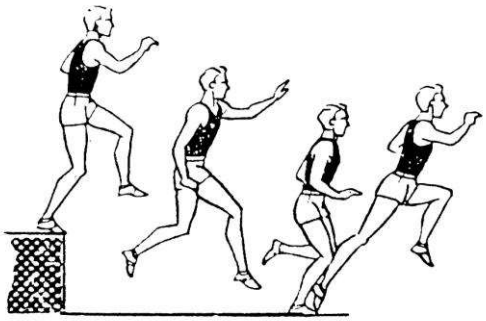
In addition, you can use incline sleds and weighted swings with contact made against a resilient surface or a force platform. The force platform can be used to measure the amount of force you are generating in the hits and in push-off or it can be used strictly as a training device.

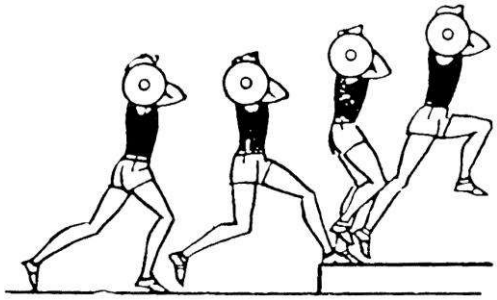

а
б

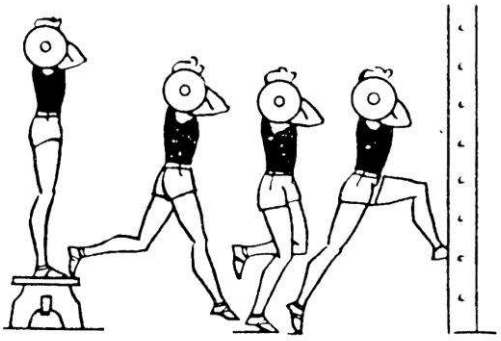












Chapter Six

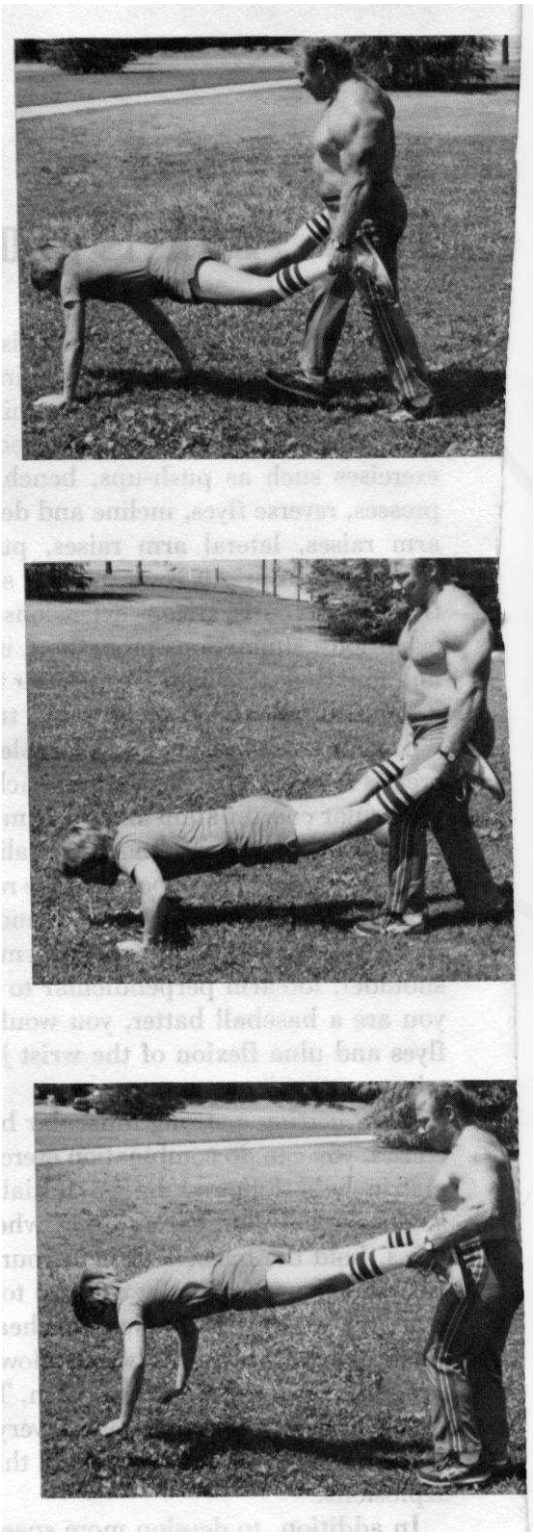
Explosive Arms for All Sports

In general, the same progression is used for explosive arms as it is for explosive legs. First, you must begin with all-round general strength training for the shoulders and arms. Thus, for the upper body you should do exercises such as push-ups, bench presses, overhead presses, reverse flyes, incline and decline presses, front arm raises, lateral arm raises, pullovers, bent-over, seated, and upright rows, medial shoulder joint rotation, biceps curls, triceps extensions, wrist flexions and extensions, supinations-pronations, ulna and radial flexion, and finger flexion. Please refer to Chapter Two for a detailed discussion on strength training.

It is difficult to bring out examples of specialized exercises for the upper body since each sport has its own particular coordination and basic movements. Thus, if you are a shot putter, a more specialized exercise would be incline presses as opposed to the regular bench press. If you are a thrower, you would do more medial shoulder joint rotation with the upper arm in line with the shoulder, forearm perpendicular to the upper arm. If you are a baseball batter, you would do more reverse flyes and ulna flexion of the wrist joint together with triceps extensions.

After getting a strong muscular base from these exercises, you can do combination exercises such as an isometric hold followed by an initial explosion in the beginning position. For example, when doing the bench press, hold the barbell close to your chest for a count of 5 and then maximally explode to raise the barbell. However, make sure the weight is heavy enough so that when you explode the bar will be slowing down and stop as your arms come to full extension. To ensure that your arm is not moving explosively or very fast near the end of the range of motion, you should think of short, quick explosions.

In addition, to develop more speed you can execute the exercises at a faster rate of execution but always with the barbell coming to a stop or being quickly reversed near the end of the range of motion. After this, you will be ready for jumping with the arms.



Jumping With The Arms

This can be done in several ways as follows:

Wheelbarrow walk. Have an assistant hold your legs up off the floor and you hop on your hands with small take-offs with double arms.

Push-up jumps. Assume the push-up position and leap up off the floor and then back to the push-up position.

Assume the push-up position. Push off the floor and leap up to a block approximately 4" high. As you improve in your ability to jump upward, jump up as high as you can, up to \L2'.

Arm jumps over objects. As you jump up and over the objects from a push-up position, your feet will slide so that your body is still in good position.

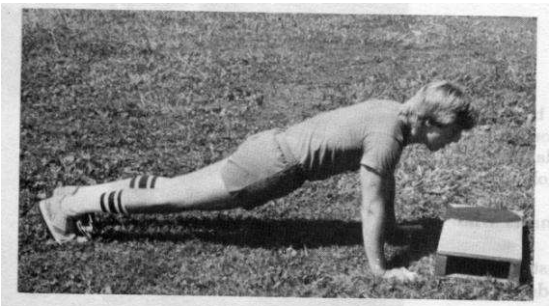
Jumps sideways over a low object. These are very short range sideward jumps from a push-up position.

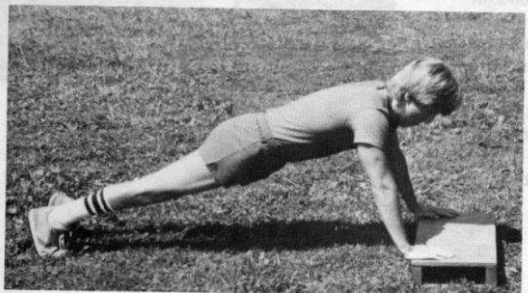
Push-up jumps with a hand clap. From the push-up position jump up as high as possible and clap the hands. As you improve try to increase the number of claps that you can execute prior to landing.

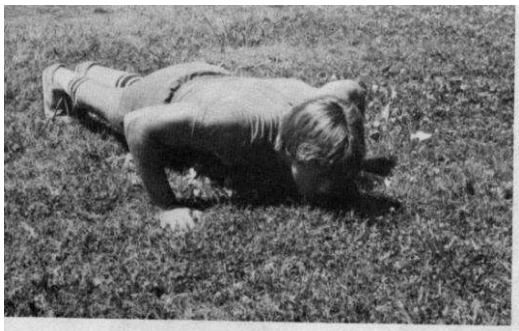
Stair jumps. Assume the push-up position in front of a stairway. Jump up to the first step, get yourself set again and jump up to the next step and so on. Go up about 4-5 steps. As you improve have a partner hold your feet as you jump up the flight of stairs.

Assume a push-up position on the floor wearing socks on your feet so they'll slide across the floor. Do a series of 5-10 jumps in a forward line.

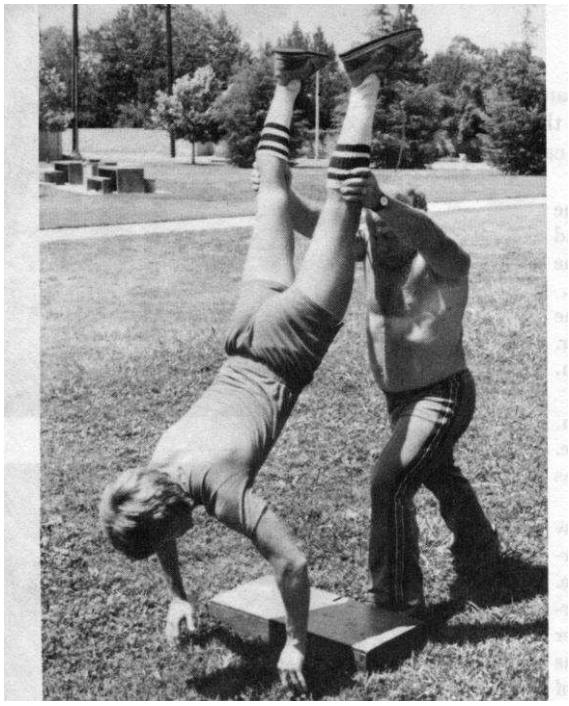
Same as above. Instead of traveling in a forward line, go in a slightly zigzag line forward.



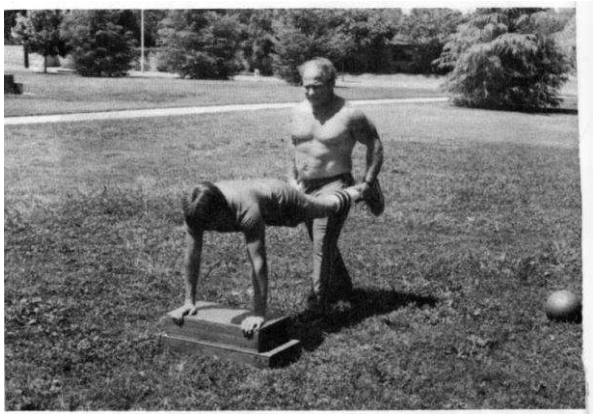




Depth Jumps



Assume a handstand position on a raised box approximately 6-8 inches high. Jump off immediately on landing, jump upwards as high as possible. Upon landing, go into a front roll or have someone catch and hold your legs after you leap upward. Such depth jumps are excellent for gymnasts who need explosive overhead strength.



Athletes such as football players who must use the hands and arms to repel an opponent should do the depth jump shown immediately above:

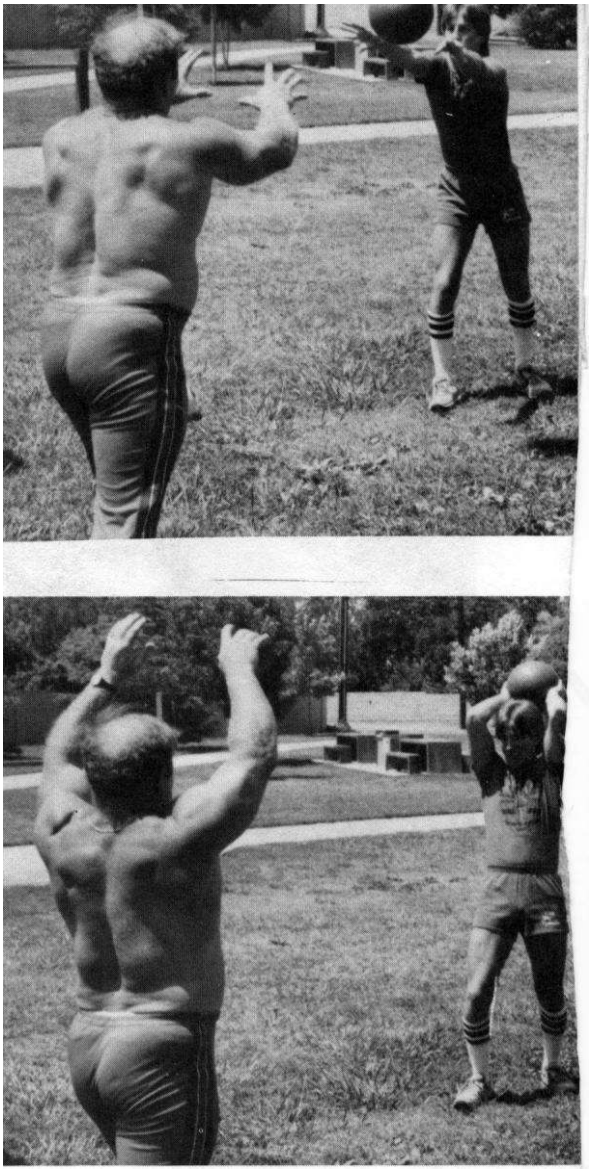
Assume a push-off position on the first step of a double modified staircase. Leap up, land in between the staircases and then immediately jump up onto the first or, if possible, second step. From the second step leap up, land on the floor, and explode up to the second or, if possible, third step.

The depth jumps can also be done with a partner holding your feet. Assume a push-up position with a partner holding your feet and your hands on a box with the shoulders directly above. Jump down from the box, land, and immediately explode upward. Your partner keeps your legs up high enough so your body does not hit the box. The boxes should not be so high that your body makes contact as you drop down.

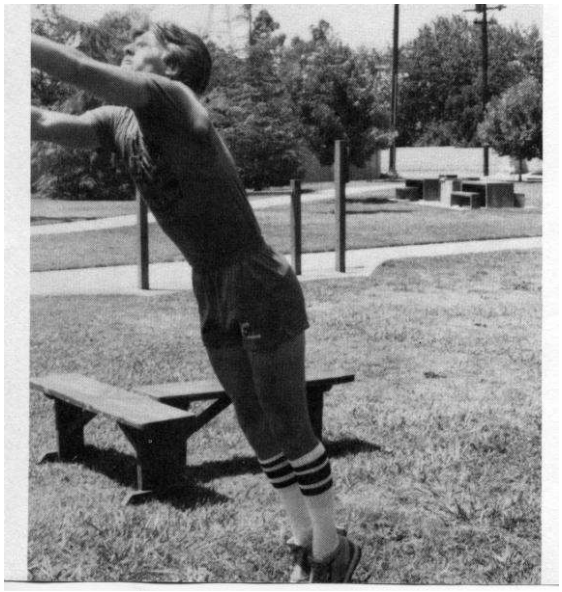
Medicine Ball Exercises

The catching and throwing of medicine balls or sand bags or other objects can also be used to develop the arms and upper body. Some of the exercises that can be used are as follows:

1. **Medicine ball chest pass between two players. The key to execution is making the passes as forcefully and as quickly as possible. Do not cushion the ball all the way to the chest. As soon as you receive it, repel it.**
2. **Overhead pass. Throw the ball from behind the head forward and/or upward and forward to a partner. Have him return it so you can catch and throw again. Do it 8-10 times.**
3. **Side arm pass. Assume a front facing position. Have your partner throw the ball at you to the side. Catch it, return it as quickly and as forcefully as possible.**



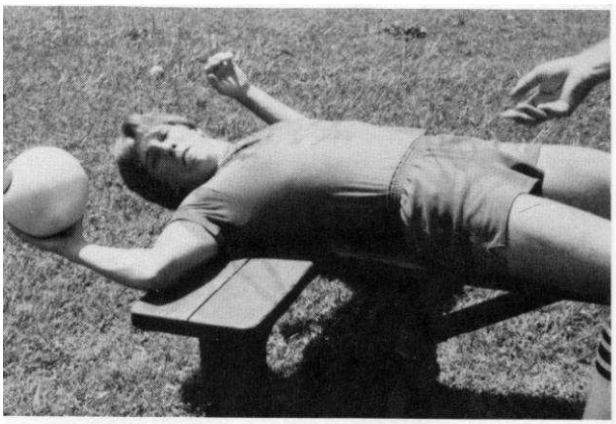
4. **Forward underhand pass. Have a partner throw a ball to you below waist level, catch and return it forward and upward as forcefully and quickly as possible.**
5. **If you are a baseball pitcher or football quarterback, assume a back lying position so that the upper arms are in line with the shoulders and the forearms are up and back. Have your partner stand in front of and above you with a light medicine ball (2-4 lbs(and throw the ball to you. Catch the ball with one arm and return as quickly and forcefully as possible. This exercise maximally develops explosiveness of the medial rotators of the arm, which is the key arm action in throwing.**
6. **For batters an excellent exercise is to stand sideways to your partner. Your partner throws the ball to you but in front of your body. You catch and repel the ball as**

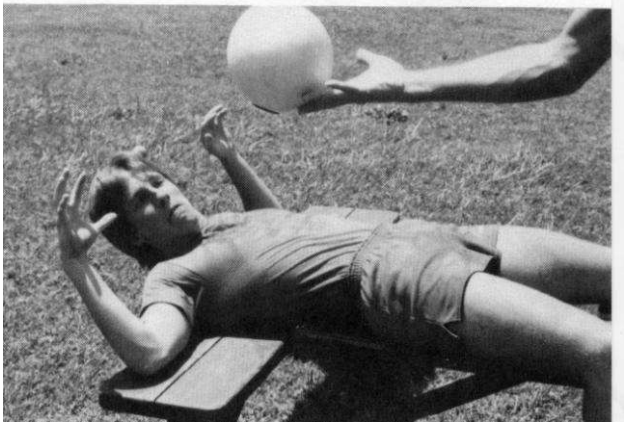


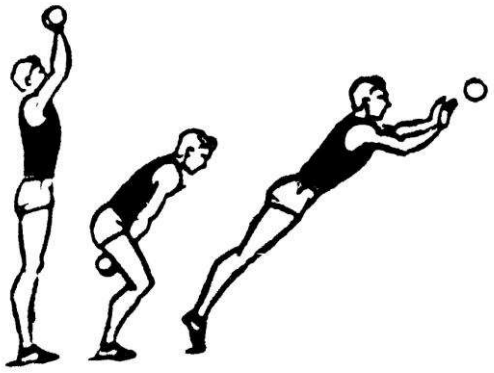
quickly and forcefully as possible. You can also use medicine balls to duplicate the isometric contraction and then an explosion. For example, hold a heavy medicine ball over and behind your head. Hold for 5 seconds and then throw upward and forward as forcefully as possible. The same can be done holding the ball in a sidearm, underhand, or ¾ arm position.

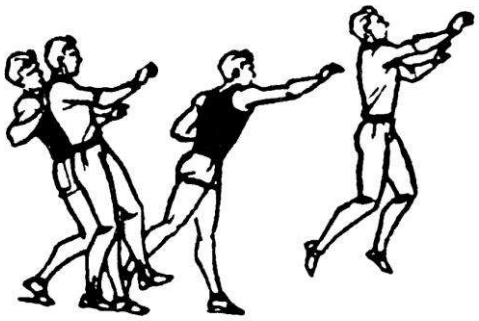
Specialized equipment to develop upper body explosiveness

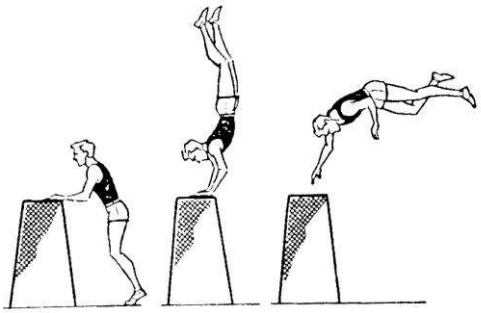
1. Set up an apparatus such as a swinging pendulum. Put weight on the end or adjust it from the end upwards to create more or less force and put it into motion. The weighted pendulum swings into you, catch it with one or both arms, and push away as forcefully as possible. As the pendulum swings back to you, repeat. Do for 5-7 repetitions.
2. If a weighted pendulum is not available, you can use objects such as a heavy boxing punching bag. Push the bag away from you and as it swings into you, catch and repel as quickly and forcefully as possible. Use one or both arms.

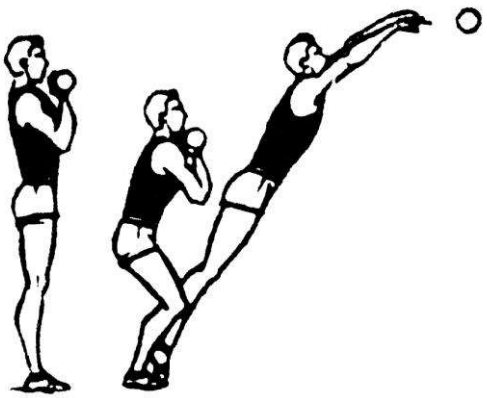


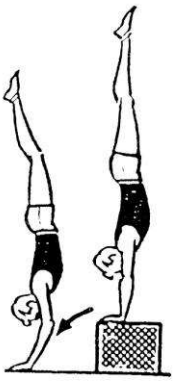


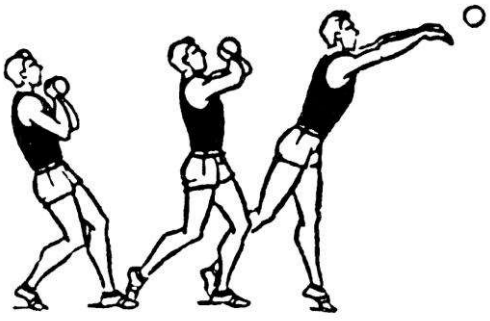


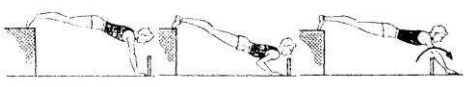


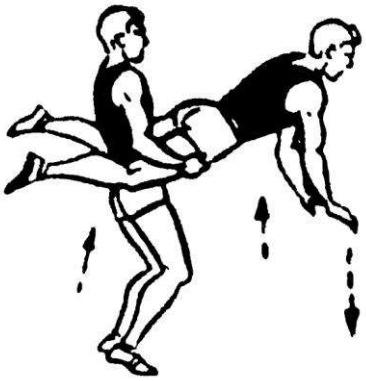


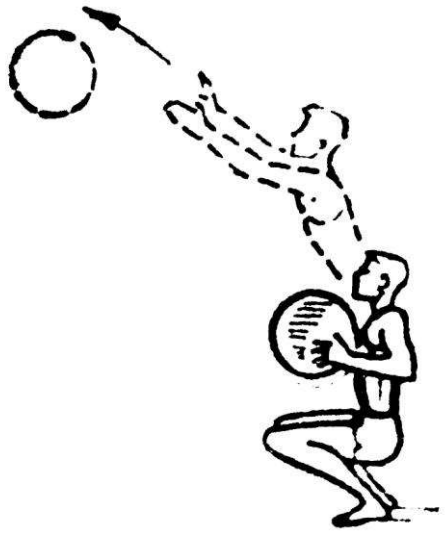


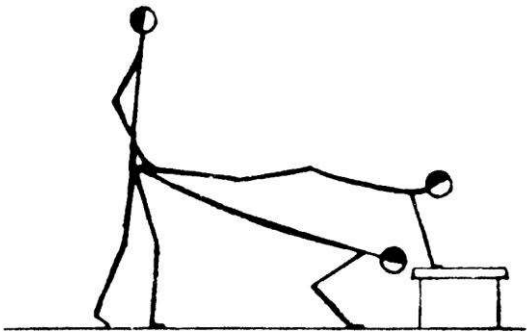


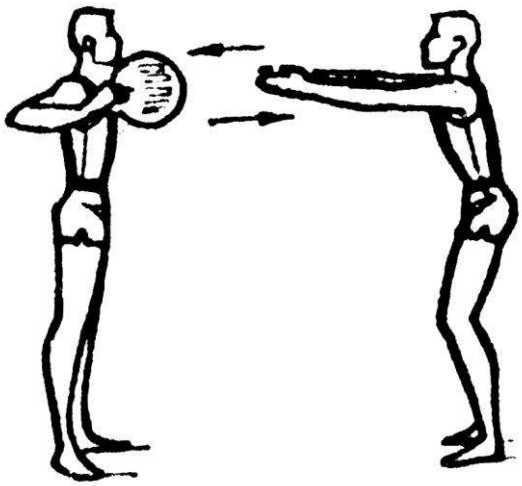


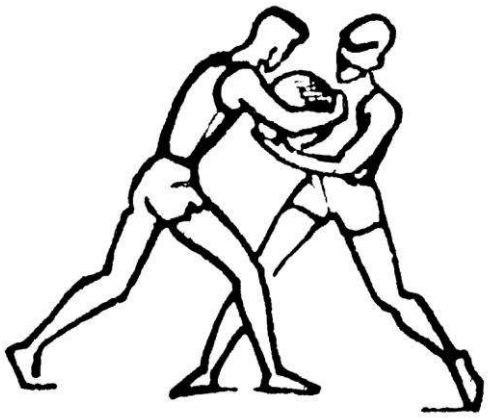


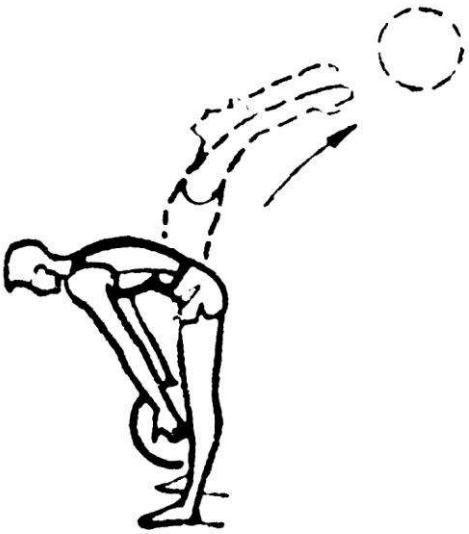












Chapter Seven

Total Body Explosiveness

Total body explosiveness is usually needed in the throwing, hitting, lifting, and pushing type events. This includes events such as baseball, football, shot put, javelin throw, discus, tennis, racquetball, the martial arts and in the weightlifting events (snatch and clean and jerk).

In these events you need both explosive legs and arms. However, because the total body is involved, it is important that you develop the midsection, which is the main link connecting the legs and arms. If it is weak and lacks explosiveness, the total force transferred from the legs to the arms will be considerably less.

Because of this, the first thing you should do is develop the strength of all the midsection muscles. This means doing exercises such as sit-ups, sit-ups with a twist, reverse sit-ups, reverse trunk twists, back raises, back raises with a twist, good mornings, deadlifts, Russian twists and bent-over trunk twists.

As you develop the muscles you can then begin doing some more specialized exercises and exercises that use the eccentric-concentric contraction with a quick switch. For example, you can do exercises such as the Russian twist, standing or seated trunk twists with a weighted barbell on the shoulders, and various snatch and clean and jerk type pulls and cleans. In addition, you should do combination type exercises such as squats followed by a heel raise or a squat followed by an overhead press and a heel raise.

You can also do a continuous pull with a heel raise (raise the bar off the floor as in a deadlift, continue pulling the bar up in an upright row, and end with a heel raise). Also, do a squat followed by a good morning, followed by an overhead press. These exercises help to unite and coordinate lower body, midsection and upper body work.

Besides doing these multi-joint exercises which involve the whole body, you should do specialized exercises for the lower and upper extremities as outlined in the previous chapters.

These exercises are followed by pre-tension to explosion exercises. In these exercises you assume a flexed position of the legs, midsection, and arms and then hold the position for 4-5 seconds with a following explosion to straighten the body. For example, you can do exercises such as:

1. **Go into a squat-tuck position holding a medicine ball, shot put or some other object in the hands just above the floor. Explode out of the squat, straighten the back, and swing the arms upward to throw the object upward and forward.**
2. **Same position but holding the ball in front of the face with bent arms. Explode out of the squat, straighten the back, and push the ball upward and forward as quickly as possible.**
3. **Assume a squat position with your upper body turned away from the direction of the throw. Hold for 4-5 seconds, explode out of the squat with a twisting of the upper body, and then push or throw the object with two hands or with one arm.**
4. **Go into a squat position holding a medicine ball on extended arms close to the floor. Explode out of the squat, straighten the back, and throw the ball backwards over your head.**

Repetitions of the above 4 exercises can be accomplished by lining up 6-8 medicine balls and quickly going from one to the next. Together with and after these exercises you should do jumping exercises. In these exercises you try to duplicate some of the movements seen in your sport. For example:

1. **If you are a high jumper, do a single leg take-off throwing the swing leg up and at the same time swinging the arms upward. These actions also develop coordination.**
2. **If you are a long jumper, execute the take-off with coordinated swing movements of the arms after a 3 or 5 step approach.**
3. **Execute a standing triple, quintuple, or ten-fold jump swinging the arms and legs upward after each jump.**
4. **Do the same thing but after a 2-3 step approach,**
5. **If you are a basketball or volleyball player, extend the arms directly overhead with each jump.**
6. **Same thing but with a fast 3-5 step approach.**

In these exercises the change of direction takes place not so much in the way you are facing but in coordinating arm and leg activity as needed in your sport. Thus, you duplicate the take-off actions for the sport you are involved in for running, jumping, or throwing.

Altitude jumps and depth jumps are done as previously described in the chapters on developing explosive arms and legs. They should be done individually at first and then added together, simulating the total skill.

Catching and throwing are the most common plyometric activities to develop explosiveness in the throws. In the catches and throws it is important that you go through the sequence of events needed in the full throw. In other words, you do not rely only on the arms or legs but total body movement in sequence. Some of the exercises that can be used are as follows:

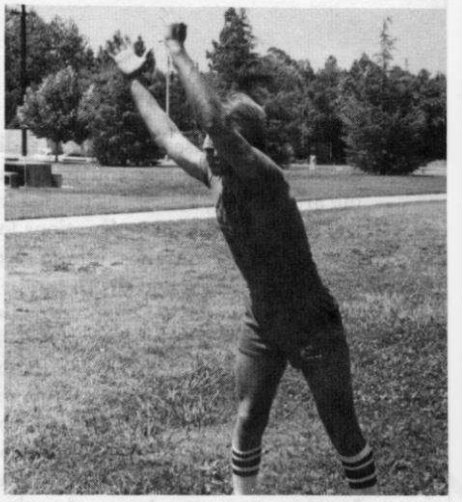
1. **Catching a medicine ball overhead followed by slight extension of the trunk and flexion of the arms and then a quick reversal with leg extension, trunk flexion, and arm extension in throwing the ball back.**
2. **Same exercise but catching the ball from a front facing position at a %. overhead position.**
3. **Same exercise but catching the ball sidearm at approximately waist height.**
4. **Catching the ball underhand and throwing with total body explosion upwards and forwards.**
5. **Jump chest pass. Hold the ball in front of the chest, go into a crouch, explode out of the crouch and push the ball off the chest as forcefully as possible. Catch the ball chest high and repeat.**

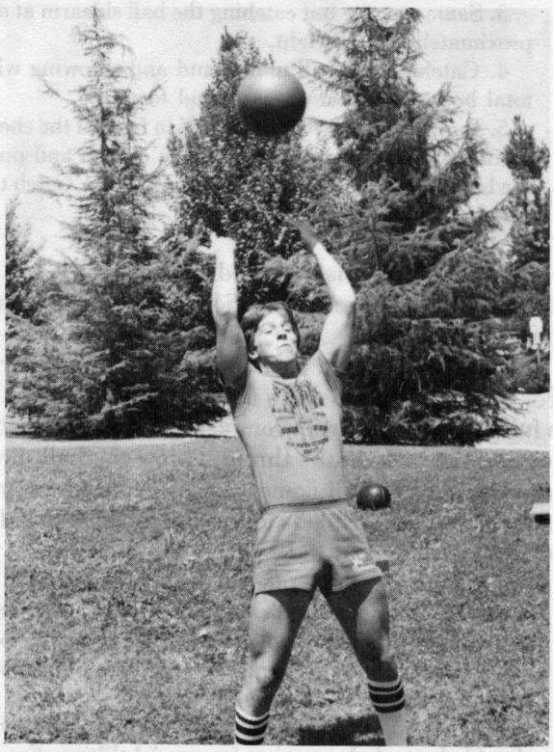
The above exercises should be executed with your body in a side facing position or in a front facing position.

Some exercises can also be done without a partner. For example, you can do an underhand toss upward from a full squat position with complete extension of the body, leaving the floor in the throw. Throw the ball directly upward. As the ball comes down, catch it, go into a crouch, and then explode upward in tossing the ball upward again. Repeat 8-10 times. Do 2-4 sets.

6. **Single arm throws for the total body can also be done. For example, duplicate the shot put. Assume a back facing position, explode with the legs, take one step, turn the body in sequence and push a medicine ball or shot put off the shoulder.**

When doing explosive movements of the body you should also include exercises from weightlifting. For example, do power cleans, power snatches, and jerks.





Chapter Eight

How to Fit Plyometrics Into Your Personal Program

Everyone should not do the same type of plyometrics or do them to the same extent. To determine what and how much you should do, you must first examine your sport. What does it require? Which skills in your sport require mainly leg explosiveness, arm explosiveness, or total body explosiveness?

Racquet Sports

For example, if you are a tennis player or are involved in some other racquet sport, leg explosiveness is most important. It is needed to help you move around the court more quickly, both to get you to the ball for a return or to get into proper positioning for an effective defense. Keep in mind that the more time you have for proper positioning, the more effective your hits will be.

Some total body explosiveness is needed in the power serves, but it is not maximal as for example in lifting a 250 pound weight as fast as you can. The key in the serve is proper sequence of movement of the various body parts and maximal speed of the racquet. Thus, the speed component is more important than pure strength.

Weight Events

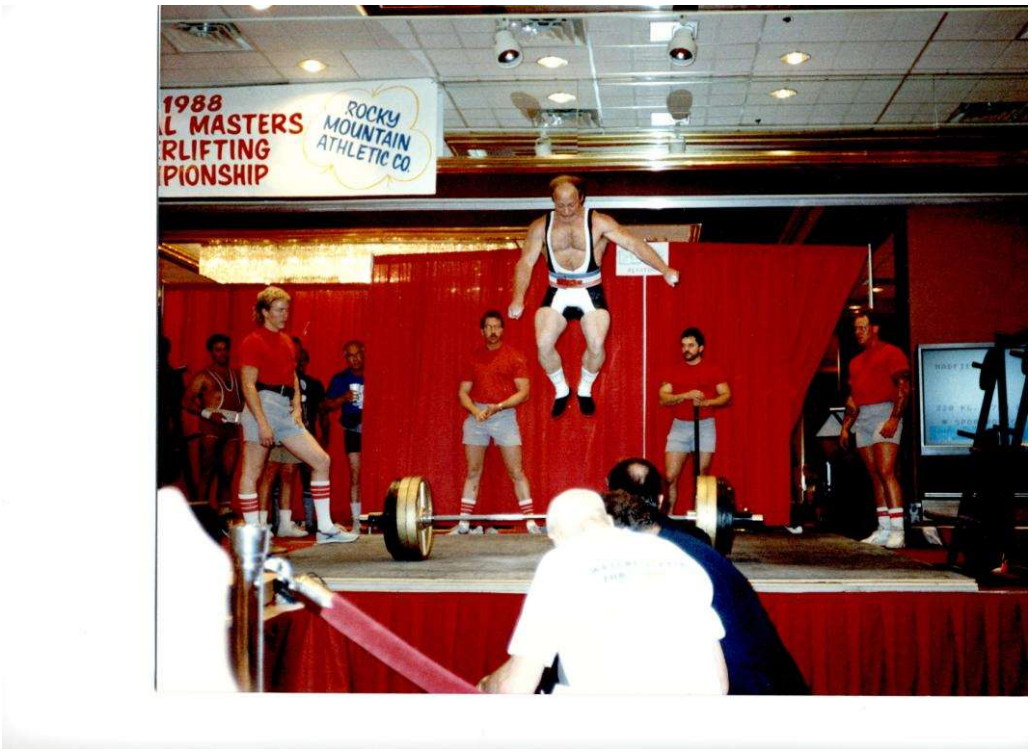
If you are involved in some of the heavy weight events such as weightlifting, shot put, and hammer throw, you will need more high intensity strength training together with maximum intensity plyometrics. You must have not only explosive arms and legs, but total body explosiveness. In such sports, much of your training will be with maximum intensity.

Multiple Skill Events

If you are involved in a sport such as baseball in which hitting and throwing as well as running and general all-around movement are most important, you need total body explosiveness with emphasis on the legs for running and fielding and emphasis on the upper body for throwing and hitting. However, because the object you handle is relatively light, you do not need maximum intensity work. In this case, jump plyometrics and exercises with the medicine ball can be quite sufficient together with some depth jumps with a jump up from lower heights.

Jumping

There are some sports that require explosive jumping but little explosiveness for the total body or arms. An example is the high jump or long jump, which requires maximum leg explosiveness. In this case, you would need high intensity strength work coupled with high intensity plyometric work. Thus, you would do maximum barbell work for the legs together with maximum plyometrics in which emphasis is on altitude jumps and depth jumps.



Vertical jumping ability comes from both strength training and plyometric training. Hatfield leaps in preparation for a deadlift (to achieve a myotatic reflex).

Weightlifting

In weightlifting, leg explosiveness is most important. It has been found that there is a close correlation between leg explosiveness (jump height) and the classical weightlifting events. The reason is that in the middle of the pull, there's actually a rebending of the knees, amounting to an actual "jump" during the pull. Thus, the more explosive your legs are, the more successful you will be in executing the lifts. Because of this, you should emphasize high intensity plyometric work or leg explosiveness in weightlifting.

Wrestling

Wrestling, which requires quick movements, requires explosiveness of the arms and legs and, in some cases, total body. Thus, all these factors need to be emphasized in training.

Gymnastics

In gymnastics it is possible to see examples of maximum leg explosiveness, arm explosiveness, and total body explosiveness. However, since only body weight is used in gymnastics, it is not necessary to develop excessive strength by lifting very heavy external resistances. However, you should do fairly high intensity plyometric work. For example, for arm explosiveness when doing depth jumps, you should only jump off a 6-16 inch height. Also, do exercises such as push-ups with a clap. Depth jumps are most important for leg and arm explosiveness.

Once you have established what qualities your sport demands and the level of intensity that is needed to develop the explosiveness needed in the sport, you should then go through the progressions outlined for development of explosiveness. In summary, they are:

1. **First develop general total body conditioning. As you do this put emphasis on the body parts most important, (i.e., legs, arms, or total body).**
2. **Move into specialized exercises that more closely duplicate the sports event. As you do these exercises, you can begin to do some static holds with explosive type movements and easy jumping for the legs and arms, depending upon the sport.**
3. **When you have developed an adequate base, begin doing altitude jumps if you're a jumper (optional for other sports). If you are involved in the heavy weight sports you should be able to do a squat with 2-2.5 times body weight before undertaking full height altitude jumps and depth jumps.**
4. **When you begin your do depth jumps be sure you gradually increase the height and do not start off with maximum height for the take-off. Depth jumping is a most important phase and is the key plyometric exercise for development of explosiveness in the arms and legs.**
5. **This phase is followed by the catching and throwing (receiving and repelling) with various pieces of equipment. Various medicine ball exercises are used to a great extent in this period. Some of these exercises can be done simultaneously with other plyometric work.**

The key is that you follow this progression, especially if you will be handling heavy weights. If your sport requires light explosiveness or light activities, then you can do many phases of the progression simultaneously. By following this progression in developing your level of strength and explosiveness, you will find that your speed of movement will increase greatly. You will be able to knock tenths to full seconds off your running times. In jumping you can improve as much as two feet or more, depending upon the level at which you start. In addition, you will find yourself throwing further, faster, and quicker than ever before.

Most conditioning and strengthening work should be done early in the season. It should last anywhere from 1-3 months, depending upon your initial level of conditioning. The higher your level of conditioning, then the less conditioning work you have to do. Thus you can start doing more specialized work sooner as well as plyometric work. Easy plyometrics such as the jump series can start after you have achieved a base strength level. They can be done on a year-round basis.

Depth jumps, however, should only be done after fairly intense weightlifting and many different kinds of jumps. Keep in mind that the best height for depth jumping is between 30-40 inches. Jumping from the 30" height is more suitable for speed development, while jumping from the 40" height is more for the strength component. Of course, this applies to athletes with a low fat-to-muscle ratio (below 10-12% body fat). For heavier athletes or beginning athletes, the height must be adjusted downward accordingly. Weightlifters over 100kg bodyweight, for example, should do depth jumps from a height of 50-60 cm (approx. 20-25//).

Very high level athletes can also do depth jumps from lower heights with the landing and take-off executed with contact only on the balls of the feet. This is especially appropriate for top level sprinters and some jumpers. It is not recommended for beginning or intermediate athletes or even high level athletes who do not experience maximum sprint speeds or maximum jumps.

Depth jumps appear to be very easy and non-taxing on the body. However, they provide a very powerful effect. Because of this, they cannot be used on a year round basis. As already brought out, they must only be done after a good strength base has been developed. In addition, prior to doing depth jumps, it is necessary to do many

other forms of plyometrics, especially different kinds of jumps which are relatively moderate to weak in intensity. In this case, the jumps will help develop your ligament and tendon strength and provide muscular conditioning for more intense work later.

In general, the following sequence is used before depth jumping at the "ideal" heights. At the beginning, for approximately six weeks, jump exercises of weak intensity are done. Near the end of the six weeks (approximately after 4-5 weeks) exercise with weights to develop maximum strength are used. This also continues for six weeks. However, after the 4^{th}-5^{th} week, depth jumps are gradually introduced. Start at a low height and gradually build up to the optimal height for your particular sport. The depth jumps are continued for the duration of the six weeks.

At the time when exercises with weights and depth jumps overlap, competitive period exercises should also begin. Thus, your body development (increased strength and explosive strength, which is received from the exercises with weights and the depth jumps) corresponds to the competitive exercises. However, as you get ready for major competition, depth jumps and altitude jumps should not be used. If you have a very long competitive period, there must be stages in which maintenance work for both strength and explosiveness is done.

To develop and to maintain maximum strength (maximum force) together with explosive ability, following are some combinations of work that can be used. They involve what the Soviets call the "complex method" in which you use heavier and lighter activities to train your body to adapt to the competitive load and to new record loads.

1. **a) Barbell weight at 90% of maximum. Two sets of 2-3 repetitions of squats.**
   b) Depth jumps 2x10 at a height of 75cm. Do this entire combination for 2-3 sets. Rest 4-6 minutes between sets.
2. **a) Weight at 90%, 2x2-3 squats.**
   b) Kettlebell jumps for explosiveness. (Straddle two benches so that the kettlebell goes down below the level of the benches.) Do 2-3 sets of 8 repetitions. This entire complex is done 2-3 times.
3. **a) Squats at 90% of maximum. 2x2-3 repetitions.**
   b) Quintuple jumps in succession. Do two sets of 6 jumps in succession. Rest between sets is 3-4 min. The entire complex is done 2-3 times.

Catching and throwing type plyometrics should be done closer to the actual start of the season or in the pre-competitive phase. The reason for this is that they should more closely duplicate the actual skills involved in your sport. However, you should not do plyometrics, especially if they are intense, right up to the time of competition. Plyometric work should stop 2-3 days to 1 week prior to competition. However, if the plyometric work is very intense, it should stop 1-2 weeks prior to competition. The less the intensity of the work being done, the closer to competition you can do them.

References

Personal interviews with Drs. Alexev Medvedev and Yuri Verkoshansky by the authors during trips to Moscow. At the time of the fiorst writing of this book (1986), Medvedev was an honored weightlifting coach and professor at the Moscow State Institute of Physical Culture & Sport. And, Dr. Verkoshansky was professor and speed & strength training specialist at the Moscow State Institute of Physical Culture & Sport.

SOVIET SPORTS REVIEW (editor: Michael Yessis, Ph.D.)

1. **Are Depth Jumps Useful? Vol. 3 #3, September 1968.**
2. **Perspectives in the Improvement of Speed-Strength Preparation of Jumpers, Vol. 4 #2, June 1969.**
3. **Jumps in the Training of A Sprinter, Vol. 9 #3, September 1974.**
4. **Jumps—The Take-Off Mechanism, Vol. 9 #4, December 1974.**
5. **Speed & Strength, Vol. 10 #3, September 1975.**
6. **Experimental Data on the Use of a Special Training Device for Young Track & Field Athletes, Vol. 12 #4, December 1977.**
7. **How to Develop Jumping Ability, Vol. 13 #1, March 1978.**
8. **Different Work Regimes in Special Strength Training, Vol. 13 #1, March 1978.**
9. **A Training Device for Development of Jump Strength, Vol. 10 #1, March 1975.**
10. **A Training Aid for Sprinters &Throwers, Vol.14 #1, March 1979.**
11. **Strength Training of Jumpers, Vol.14 #2, June 1979.**
12. **Speed-Strength Training for Skilled Weightlifters, Vol.16 #2, June 1981.**
13. **Execution of Jumps for Height, Vol.18 #2, June 1983.**
14. **Execution of Jumps for Height, Vol. 18 #3, September 1983.**
15. **Training for A Quick Take-Off in Jumping, Vol.18 #3, September 1983.**
16. **Speed-Strength Preparation of Future Champions, Vol.18 #4, December 1983.**
17. **Speed-Strength Preparation of Weightlifters In the Pre-Competitive Stage, Vol.19 #1, March1984.**
18. **Modeling Speed-Strength Preparation of Weightlifters, Vol. 19 #3, June 1984.**
19. **Speed-Strength Structure of Vertical Jumps by Qualified Weightlifters in Different Take-Off Conditions, Vol.19 #4, December 1984.**
20. **Improving Speed-Strength Endurance in Wrestlers, Vol.20 #2, June 1985.**

21. Specialized Physical Preparation of Gymnasts in Support Jumps, Vol. 20 #4, December 1985.

Copyright © 1986, 2007 Michael Yessis and Fred Hatfield. All rights reserved. No part of this information may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording, distributing, or by any information storage or retrieval system, without permission in writing from the author. Inquiries should be addressed to DrSquat.com Webmaster, 6006 Eldorado Drive, Tampa, FL 33615, USA. If you would like to offer any of the e-books on www.drsquat.com , whether on your site or elsewhere, please contact DrSquat.com Webmaster at the address above or via e-mail at admin@drsquat.com.

For complete information on all Dr. Squat's e-booklets, products, programs and more valuable information available to help you get stronger, faster, healthier, lose fat or train for your sport, visit www.drsquat.com.

For complete information on all Dr. Yessis' e-booklets, products, programs and more valuable information available to help you get stronger, faster, healthier, lose fat or train for your sport, visit http://www.dryessis.com.